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ABSTRACT

The following papers are included: "Technological Literacy: Pedagogy for a New World Order" (Peter McGregor); "Career and Technology Studies, A Curriculum Model" (Clarence Preitz); "Vocational and Technical Education at Secondary Schools in Taiwan, Republic of China" (James Yu); "Blueprint for Literacy in Technology" (Jerry Balistreri, Douglas Hammer); "Critical Technologies for Economic Growth" (Harry Armen); "Applied Industrial Technology--A Junior High Technology Program" (Jim Fellenberg); "The Blueprint for Literacy in Technology" (Don Bernard); "Technology Education: A Review of the Anchorage Project" (Kendall Starkweather); "Tools for Overcoming Thought Barriers--The Missing Element for Developing Technology Education" (Dietrich Blandow); "Technology Education in Japan" (Shoji Murata, Sam Stern); "Interdisciplinary Technology Programs in the Republic of Peru" (James Yu); and "Business Education Partnerships--A Role in Enhancing Technological Literacy" (Brian Swanson). (NLA)

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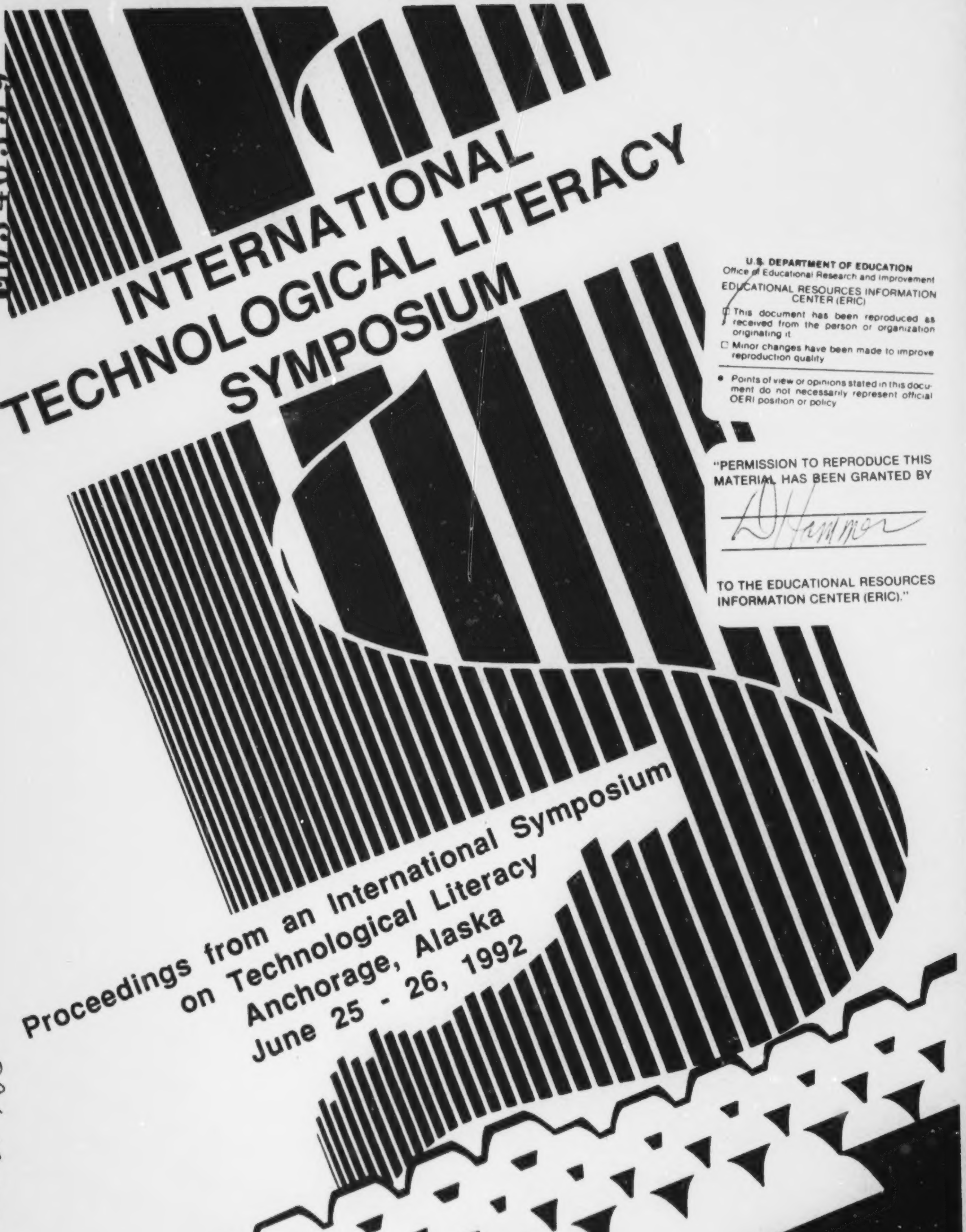

INTERNATIONAL TECHNOLOGICAL LITERACY SYMPOSIUM

Proceedings from an International Symposium
on Technological Literacy
Anchorage, Alaska
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Forward

This publication is a compilation of the papers presented at the *International Technological Literacy Symposium* in Anchorage, Alaska. Funding, in part, was provided by a grant from the U. S. Office of Vocational and Adult Education, U. S. Department of Education. As part of that grant the symposium was developed as a means to disseminate the results of the Alaska Technological Literacy demonstration project and to assemble representatives of various countries to discuss the processes and developments in teaching technological literacy in their respective countries.

Appreciation is extended to all who have assisted to facilitate this symposium. Hosts for this conference were the Anchorage School District and the University of Alaska Anchorage. As project directors, we welcome all who have chosen to participate and offer our time and resources to make your visit as enjoyable as possible.

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Technological Literacy: Pedagogy for a New World Order

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Technological Literacy:
Pedagogy for a New World Order *

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* Paper presented to the International Technological Literacy Symposium June 25-26 1992 Anchorage, Alaska

** The Centre for Economic Education Inc is a non-profit organisation which aims to promote greater understanding of economic considerations in public debate; in particular, to raise the awareness of students and teachers to the importance of economic aspects of public issues.

Technological Literacy:

Pedagogy for a New World Order

Technological literacy involves more than mere technical competence. It requires an understanding of the dynamic social and economic forces that shape society, the technological innovation that accompanies change, as well as the potential risks. The challenge that educators in many countries face today is to find meaningful ways of bringing science and technology, technical innovation and problem-solving into curricula for all students.

Importantly, the irrational suspicion of technology that is harboured in some communities should not prevent young people from being introduced to the competencies and impacts of technological change -- unique forces in modern societies capable of enhancing the lives and work of the world's people.

Let me begin with an illustration of what technological literacy isn't.

In 1928, Gary Cooper and Nancy Cooper were in the final scenes of a film called "Shopworn Angel" for Paramount Pictures. At that point, it was decided by the powers-that-be, that the new technology of sound should be incorporated into the film. At the last minute, some dialogue was added. Cooper said,"I studied my script containing this new thing called dialogue until it was letter perfect."

In the closing seconds of the movie, a wedding scene, the first and only words were spoken. Cooper said,"I do." Carol said,"I do". The film was released to an astounded world as a talkie. Paramount had entered a new age with a gesture towards a promising new "technology".[1]

I believe -- under the rubric of "technological literacy" -- we are talking about more than gestures.

It is difficult today to think about the modern world in which we live without thinking about the myriad of technologies that support it. Almost every aspect of everyday living in the late twentieth century depends on one form of technology or another. Health and medicine, food and agriculture, transport, homes, minerals and manufactures, energy, education, information and communications, travel, the environment. Technology is what we do to do things better than before.

Traditionally, new technologies have provided more and more people with increasing opportunities to be more fully human. They have continually created new resources and new possibilities. Though not faultless, without technology, our labours would be little other than the primitive effort of animals to obtain subsistence, and survive. Faster, cheaper, less effort; conserving one of our most precious resources, our time. Without it, we wouldn't recognise ourselves. Yet, technology is one of the least understood concepts of our age. Although we very often use the terms 'science' and 'technology' together, they are not one and the same thing.

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[1] This story appeared in a pamphlet: *Science Shopping*. The Science Shop, Melbourne. Vol 2 No 2.

Technology is very different from science; and, sadly, its status inferior. The world's great scientists -- Newton, Galileo, Faraday -- are generically distinct from the great technologists such as Edison, Tesla and Ford. Science educator, Professor Peter Fensham of Monash University in Melbourne writes: "Scientists basically are comfortable with notions like 'discovering' or 'uncovering' nature. Technologists are more comfortable with words like 'design' and 'invention'." (Fensham, 1990)

In Australia, acceptance of the central role of technology has become orthodoxy, even amongst those (such as militant unions) who once so fiercely resisted its contemporary manifestations. (I am told that the adoption rate of some domestic appliances throughout the country are unmatched anywhere else in the world.) At the same time, the government is urging people in universities, companies and organisations like the CSIRO[2] to create Australia's future through scientific effort. It is widely accepted that their success in developing new technologies will shape our environment and largely determine the strength of our economy and the standard of living we will share in the years ahead.

In an interview for the *Australian Rural Times* the head of the CSIRO, Dr John Stocker, predicted a bright future for science and technology. He suggested that Australia will achieve world recognition in a range of new technologies including plant biotechnology, medical biotechnology, astronomy, minerals processing, animal biotechnology, cleaner fuel sources, scientific instruments, and climate research.

We will see.[3] If this is the future, education in countries like ours will be faced with a radical challenge to many of the assumptions about course content and learning that were previously held.

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[2] Commonwealth Scientific Industrial Research Organisation, a national government-funded research institution that has played a leading role in the development of science and technology in Australia for many decades.

[3] At the time of writing, the CSIRO and a national shipping line have announced the development of a new plastic wrap that puts fresh food and flowers to "sleep", which could add $300 million a year to Australia's export income. The new plastic, called "active packaging", increases the shelf life of produce by several weeks enabling fresh fruit, vegetables and flowers to be sent overseas more cheaply by sea instead of air.

Why Technology?

For two centuries, since the Industrial Revolution, standards of living for most of the world's population have continued to rise dramatically; especially life expectancy [4]. World food production has far outstripped the growth of population. Thanks to the widespread adoption of new technologies in every sphere of life, ordinary people throughout the world -- for the first time in history -- have begun to enjoy comparatively happy lives. Clean water, adequate food, accessible sewerage, affordable clothing, vaccinations, and a wide range of appropriate resources (including energy) are now available to much of the world's population because of both simple and sophisticated technological innovations.

Yet, for many people in our society -- including students -- technology has seemed an irrelevancy. In some quarters, it is the basis for considerable suspicion, even hostility. One critic of technology, Canadian broadcaster Dr David Suzuki -- a geneticist and specialist in fruit-fly reproduction -- has been a regular visitor to Australia in recent years. "Undaunted by our failure to design a foolproof technology," he writes in *Inventing the Future* (Suzuki, 1990),"our technocrats remain filled with faith in their own ability to correct all our problems with still more technology."

His constant theme is that science and technology do not come without serious side-effects. In fact, he blames technology for most of the world's present problems. Furthermore, he says, most scientists in the world direct their energies to military uses. "Over half of all scientists and engineers in the world work directly for or with research grants from departments of defence. While this application of new insights for destructive purposes is not new, the scale and scope of modern military establishments is without precedent.....It is a grotesque perversion of the high ideals of the scientific community for its ideas and discoveries to be used for destruction and death."

Environmental publicists like Suzuki paint a poor picture of technology for their readers, rarely acknowledging the enormous benefits to humankind, without which all our lives would be "nasty, brutish and short". In fact, while few might rejoice at the necessity for military research, the list of spin-offs is not unimpressive: rechargeable batteries, long-life batteries, solar cells, nuclear electricity, transistors, computers, satellites for remote sensing, communications and imaging, medicines for the fight against malaria and yellow fever, seat belts, microwave ovens, teflon, ceramic cookware, food preservation techniques, lightweight luggage, furniture and appliances, nylon, kevlar, weather satellites, graphite for fishing rods, golf clubs and tennis racquets, and numerous other things.[5] The eccentric experiments of the Wright brothers were funded by the US army. The development of components that made possible portable video cameras resulted entirely from funding from the US military and NASA.

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[4] Perhaps the technologies that have made the greatest impact on life expectancy in the last 200 years (apart from food and vaccinations) are those associated with sewerage and hydrology. Most of the diseases that afflicted humankind throughout past centuries (and still debilitate millions in Third World countries) are water-borne. Where water quality and sewerage facilities are made available (especially in towns and cities), human health and longevity improve dramatically.

In his book *Passage to a Human World*, Max Singer cites examples of opinions that are often held by people who fear technology: "New technology is potentially so dangerous, and so difficult to control because of the vested interests that it creates to support itself, that on average it is likely to do more harm than good.....We can't be too careful of new technology. Before it is introduced we must really establish its safety before it gets out of control." (Singer, 1989)

Despite the evidence of a century of rapid technological change, accompanied by improving life opportunities for most people in most countries, technology is perceived as doing more harm than good; or, at least, an unnecessary risk. Some cling to the utopian ideal of zero risk. Not that risks of technology (or simply being alive) should be ignored. In the influential Bruntland Report, the World Commission on Environment and Development drew attention to the promises and risks of new technologies that are emerging around the world.

"Technology," it noted, "will continue to change the social, cultural, and economic fabric of nations and the world community. With careful management, new and emerging technologies offer enormous opportunities for raising productivity and living standards, for improving health, and for conserving the natural resource base." But, it added," Many will also bring new hazards, requiring an improved capacity for risk assessment and risk management." (WCED, 1987) Proceed with caution, advises the Commission.

Singer, on the other hand, believes that if individuals have either an excessive or inappropriate suspicion of technology, they may well make personal decisions that unnecessarily endanger their own lives. For example, the person who rejects modern medicines, vaccines, pesticides or other chemicals

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[5] For fuller discussion of this issue, see Luchsinger and Van Blois."Spin-offs from military technology: past and future" in *International Journal of Technology Management* (Vol.4 No. 1 1989).

(such as disinfectants or for water treatment), or new technologies for electricity generation, efficient forms of communication, transport or travel, may be taking a far greater risk than that involved in using them.

In November last year, *Nature* magazine reported that in the 1970s the Peruvian government decided not to chlorinate water supplies, citing a study by the US Environment Protection Authority which found there was a small risk of chlorine reacting with organic compounds in water to form trihalomethanes, suspected carcinogens. This tragic decision was probably the cause of the cholera epidemic sweeping nations in South and central America today. Formerly absent from the continent, cholera is now rampant in a dozen countries; it has taken 3516 lives and more than 300 000 cases have been reported. Is a relatively small cancer risk preferable to a possible microbial epidemic?

Understanding Technology

One of the mistakes most commonly made in teaching about technology is the assumption that there is something essentially 20th century about it. In fact, technological change has been with us for thousands of years; humankind's dependence upon technology might well be seen as one of the defining characteristics of what it is to be fully human.

Technology, after all, is simply human ingenuity in action; nowhere conveyed more convincingly than on public television in Robert Raymond's *Out of the Fiery Furnace*. The series is the kind of general education that has the potential to put technology in its proper perspective; and it has been adapted by many schools and (particularly) colleges, both in Australia and America, to illustrate the forces of change that are linked to technological innovation.

An epic television documentary in seven 50-minute episodes, *Out of the Fiery Furnace* was made for world-wide release in 1986 through the sponsorship of Australia's largest mining company, CRA Limited. Originally shown on the government television network over seven weeks, it was intended to record the contribution of mining and minerals throughout human history.

"[A]lthough the origins of metallurgy are obscure," he writes in the book of the same name published in parallel with the television series,"we know that it developed not by a linear progression of individual achievements, but rather through scattered bursts of innovation and discovery against a broad, slow advance in technology. Whether or not an idea took root in any particular area seems to have depended upon whether society was ready to receive it and economically capable of developing it...." The series' raison d'etre is that every sizeable group of people today relies upon metal artefacts to provide the food, shelter, energy, transport and industrial products that make life comfortable.

Fiery Furnace is the story of how humankind, by discovering and learning to use various metals in appropriate ways, reached this stage of technological development. It is, says Raymond," a chronicle of curiosity and imagination, of luck and perseverance, and of uncountable lifetimes in the mines and at the forge and furnace." (Raymond, 1984) What the program tells us is that technology can be equated with the accumulation of systematic knowledge and the application of known scientific principles to solving important, enduring human problems. Since the dawn of history, people have developed their own technologies for drilling, chopping, slicing, polishing, scraping, sawing and measuring -- to improve their material welfare. Each technology, based on inventiveness and the available resources, played a part in helping one group of people (or more) inch its way forward.

What we call innovation involves a process of creating and implementing a new idea for accomplishing something that wasn't possible before; or, at least, at the level that the new technology made possible. Technology may involve tools -- mechanical, electronic or chemical. In the first instance, however, it is knowledge of scientific principles and laws that matters; followed by their appropriate application.

First, there is "invention"; perhaps the production of a workable model. Second, development follows, where a product or process is tested, refined, manufactured. Important, too -- though usually overlooked by historians and others -- is the necessary marketing and promotion that leads to widespread adoption.

We tend to forget that commercialism -- especially competition and mass production -- takes new products out of the hands of an elite (only those who can afford the luxury models) and places them at the disposal of the masses. Consumer societies, for all their faults, democratises inventions. The ballpoint pen, for example, which was once the plaything of royalty is now as cheap as chips and available to everyone. So also, motor-cars, air travel, computers and the myriad of other consumables we take for granted.

What this remarkable television series achieves is to remind us how dependent we have been, and are, upon some fundamental, life-enhancing technologies for almost everything we do. It reminds us also about the wonderful ingenuity of humankind in many places throughout the world and over aeons of time.

But such progress is not always unencumbered. In its infancy, electricity was widely feared. Many people opposed it because of the risk it posed to their neighbourhoods. It is said that Thomas Edison's mother was afraid that electricity would leak from her power point and engulf the house. Apochryphal or not, who can explain a technology of such universal advantage as electricity experiencing resistance and hostility?

Materials Technology

Fiery Furnace, with its sweeping panorama of technological evolution and change, records the diversity and creativity of human imagination; but a similar message has been carried in a multiplicity of ways. In his excellent book *The Materials Revolution*, Queensland academic Tom Forester claims that three mega-technologies will dominate the last decade of the twentieth century: information technology, biotechnology and new materials. Yet, he writes, only the first two have attracted the attention they deserve.

"New materials, on the other hand, have not been so widely written about, and their importance is less well understood by the general public. Indeed, their existence is barely touched upon in many university and college courses that should deal with such matters." (Forester, 1988)

Dramatic breakthroughs have been achieved with, for example, materials that become superconductors at very high temperatures, making it possible to produce cheaper energy, super-fast trains and perhaps spark another revolution in electronics (what Forester calls the "core" technology of today). But this leading edge of knowledge has largely been withheld from our brightest and best in schools and colleges. Almost none today would know that in 1987 a group of scientists at the University of Houston, Texas, headed by Ching-Wu "Paul" Chu, ran the equivalent of the four-minute mile in superconductivity.

Despite rapid advances in communications technology and the accelerating growth of knowledge, there are few opportunities for teachers and students to avail themselves of information that has excited scientists around the world and promises to transform the way we work and live in the future. Educators continue to cluster around traditional disciplines and traditional structures of knowledge, and transmit meanings associated with traditional materials and technologies.

The changes in the scientific world mean that we are facing a new age of technologies. In a speech to launch a superconductivity research program, President Reagan spoke of "a revolution of shattered paradigms and long-held certainties." He noted,"We are increasingly moving from an age of things to an age of thoughts, to an age of mind over matter."

Forester points to developments in ceramics, plastics and even cement as evidence of the changes that are taking place around us. "Our standard of living today has been largely determined by past discoveries of 'new' materials, and our future prosperity will in large part depend on the fruits of contemporary research into even newer materials and new materials production processes," he concludes.

But the world has changed. In the past, materials defined the technology of an era: the Stone Age, the Bronze Age, the Iron Age. Later, gunpowder had an explosive effect on warfare; glass dealt a shattering blow to the birds and insects that had traditionally sheltered inside homes. People discovered materials and adapted them to their purposes. Now, science and technology has given us the ability to design the materials we want. Tom Forester is not the first to have understood that the future will be very different from the past.

"It will become increasingly possible to predict the properties of materials before they are even made and to modify the recipe to get the desired result to suit a particular application," he says. "These so-called 'advanced materials' begin life in the mind of the scientist in the laboratory....... The shift to designer materials will thus benefit nations that are consumers of raw materials and disadvantage the traditional producer nations... The new materials technology could therefore represent an entirely new way of going about things, and as such it will present a major new challenge not only to managers, designers, and entrepreneurs but to governments worldwide."

To that auspicious list one would want to add: educators.

Technology in the Curriculum

While few today would argue against the need for more technology education in our schools, the dilemma is that there are as many conceptual frameworks as there are systems of education. In Australia, the six states have each tracked their own course; and the differences in content and orientation are significant.

Culminating in a report in August 1990, the Australian Education Council -- made up of Ministers and state education authorities -- commissioned "a map of technology education". The first of its kind, the mapping exercise provided a qualitative picture of the range of policies and practices in schools, representing a "snapshot" of perceptions, developments and exemplary practices across Australia.

The comprehensive survey concluded that "no one definition of technology education is used in all states" and "In recent years definitions of technology education have become increasingly broad. This reflects a shift from a physical and practical skills emphasis to include the more intellectually demanding processes of identifying needs, designing, problem-solving and appraising." (Aust Education Council, 1990)

In particular, say the writers of the report, productive and innovative activity in technology education develops among students the capacity to be imaginative, practical and enterprising, developing their capacity to contribute constructively to societal development. Effective learning is characterised by enterprising action, applying ideas imaginatively and exploring societal developments.

At the same time, a similar research team associated with the University of Wollongong in New South Wales concluded that there was a need for a transformation of Australian schooling resulting from 'the new order of things' flowing from the social and economic effects of new technologies. They suggested that technological literacy involved learning about, with and through technology.

"Learning about technology occurs when students discover the principles of technologies in their social and environmental contexts, with attention paid to the consequences and implications. Learning with technologies takes place when students develop technological skills and use them to enhance their learning. Where a student applies ideas, materials and resources to solve problems, a situation of learning through technologies is said to occur." (Centre for Technological and Social Change, 1990)

At the level of administration and bureaucracy, the focus on technological education has been substantial. The reconnaissance process of staking out the new terrain has been well accomplished. As always, however, the task of providing teachers and students with clear sequences, useful learning materials and teaching tools, time, training and knowledge of likely career options has been somewhat less promising.

Schools' need for continuous access to appropriate information about technology at work in society had been acknowledged many years before education administrators in Australia and elsewhere had begun to address the problems associated with declining living standards and the global economy.

The impetus for the creation of the Centre for Economic Education in Melbourne was the perceived value of a partnership-in-education between industry and schools. CEE has provided a unique leadership role in examining little-understood aspects of society, such as technology, within an economic context. It was clear from the outset that, depending upon its success, industry was prepared to support the initiative to liberate schools from traditions that had kept technology at the periphery of Australian education.

The incentive for supporting the Centre's promise to impact upon teachers, students and the curriculum was provided by increasing evidence that Australia as a nation was progressively falling behind its trading partners -- mainly Asian -- in coming to terms with a rapidly changing world and the internationalising of the world economy. The focus was to remain on economic literacy but, even within these parameters, the scope to develop resources that contributed to the development of technological literacy was obvious.

Foremost amongst the principles identified by business as requiring greater emphasis in schools and more awareness within the general community was the need for technological change and the place that technology occupied in making working people and, ultimately, businesses more efficient. CEE's role in promoting *Out of the Fiery Furnace* amongst teachers was the first of many projects for schools based on the need for greater understanding of the role of technology.

The response to the *Fiery Furnace* resource material from teachers was so positive that it was clear that much more could, and needed to, be done. The *Today's Technology* series of teaching/learning booklets was launched; the first linked by the theme of lead. The role of one important piece of Australian technology called the atomic absorption spectrometer which monitors the presence of metals, including lead, in the atmosphere was highlighted.

Today's Technology concluded,"Through continual research, and the application of a variety of scientific and technological skills, the environment is becoming increasingly safe. We have learnt to live with lead and its benefits, while virtually eliminating its hazards. Certainly, there need be no fear or ignorance of the importance of lead in our lives." Exactly the same might have been said of technology. Teachers of a variety of subject areas (not just science) saw the need to induct students into the key principles of this technology that they now realised touched so many of their lives.

In return, the Centre commissioned the production of a set of teaching notes based on the first *Today's Technology* that provided teachers with some starting points for classroom teaching and related activities. A similar process developed from the publication of the second in the series based on the application of various technologies in the paper industry in Australia.

In keeping with the growing interest in the environment, the paper-making theme allowed for an exploration of new technologies that eliminate hazardous wastes entering air and water, as well as an opportunity to elaborate on wider applications of atomic spectroscopy. These are not normally the subject of classroom discussion or learning activity, but when integrated into courses across the curriculum dealing with the environment, they become important sources of new knowledge for students. *Today's Technology* Volume 2 was to many teachers of social science, for example, a voyage of discovery into the culture of work through technology.

At a time when opinion leaders were lamenting the poverty of knowledge about work amongst students leaving schools and colleges, the need for better career information became a concern of the Centre. The mining industry commissioned materials that presented profiles of actual people at work: women and men, in cities and remote areas, using high technology to access and manipulate data related to a variety of skills in diverse careers. Diamond sorting, librarianship, geological analysis, mining, personnel selection.

The *At Work* series featured interviews with people engaged in a variety of occupations, using the latest technology, to accomplish tasks not possible in previous decades. The brief was to draw attention to the multiplicity of skills that are to be found within particular industries -- from CAD/CAM technologies and quality assurance to the use of computer graphics to design new concepts in packaging and the chemical analysis of printing inks. There is a dearth of such material in schools, written for students but sufficiently challenging and engaging to appeal also to the intellect of teachers. The profiles of young people in work places around the country explaining what they do was the appropriate vehicle to carry the relevant messages about technology into schools.

More recently, the Centre's Australian Study Topic *People and Plastics* introduced classrooms in all states to the technologies behind some of the common manufacturing products we either love or hate, but inevitably use; for example, the plastic bag. Reflecting the technological illiteracy of the Australian general community, many students were surprised to learn that plastics derived from petroleum products extracted from wells beneath the oceans near which the overwhelming majority of them live.

But such seeming trifles are only a beginning. The hard work of permanent curriculum change lies ahead for others.

Technology and Education

It has been customary in the late 80s and early 90s to look to Japan for models of technological virtue. What are the qualities that a high-tech nation like Japan seeks to foster in its institutions and youth? According to *Fortune* magazine (February 24, 1992), Sony culls the engineering schools at major universities in Japan for technical talent; but not for the best students in each discipline.

"I never had much use for specialists," says Sony founder, Ibuka. "Specialists are inclined to argue why you can't do something, while our emphasis has always been to make something out of nothing." Apparently what Sony wants are people who are optimistic, open-minded and wide-ranging in their interests. The company believes that the best technicians are those who are willing to move around and try their hand at technologies they haven't formally studied.

What, then, to teach? According to educationist, Peter Fensham, technology educators "seem to agree that there are three things that technology education ought to be contributing to learners in school. It ought to be contributing to technological awareness (or knowledge about technologies), technological capability (or how to make and do things) and technological literacy/critique (or how to be confident and not to be driven by technology). (Fensham, 1990)

In the public arena, the conflicting perspectives about technology -- from those who embrace it to those who castigate it -- can lead to confusion amongst young people. Yet a nations' competence in technology is likely to be one of the major keys to the future, especially as the paradigm shift that economists anticipate occurs world-wide; the move of economies from dependence on agriculture, raw materials and manufacturing to a mixture including a much larger component of information and services.

With the momentum for technological change gathering pace -- some commentators suggest that it may be the only revolution destined to spread over the entire world (Mikesell & Rose, 1984) -- there is a growing demand for modern communities to lift their sights and their performance. The problem is that the social and economic imperatives that face society (thanks to world-wide recession) have only just found their way into our culture and attitudes; and school curricula have been slow to respond.

But if they are to understand what is happening around them -- particularly in a global context -- it is critical that they understand more fundamentally the nature of technology itself, its interface with civilised societies, and its likely costs and benefits. This is particularly true of the present learning generation, if they are to make their way at all effectively in a rapidly changing world.

Those of us who feel some responsibility towards education must take whatever steps possible to share the key issues of technological change. We must begin to teach about technology as deliberate change, and see technology as an essential tool of liberation from drudgery and disease. Technological developments in the Year 2000 will arise from science that is already known. The future is already with us.

The dilemma for busy educators is that, while different groups acknowledge the need, there seems little agreement about how this should be accomplished; sometimes, even about basic principles. In such an environment, the principal losers are likely to be a generation of students.

Conclusion

Technological literacy is more than mere technical competence. Being able to "do" things is important; being able to solve problems even more so. But there is an intellectual framework regarding the place of technology in our lives that must be part of any program of literacy.

Technology has been the butt of dissent and criticism since the first time one community tried to work more efficiently than the generation before it. Course design may have to be set against a background of such information. But with the significant changes that are sweeping the world, there is an urgent need for schools and modern curricula to communicate society's relationship with technology. The essential ingredients of technological literacy must include an understanding of technology's key role in the economic mechanisms that provide us with food, clothing, energy and shelter; as well as an appreciation of risk assessment and technology's environmental credentials.

There must be opportunities to participate in the process of invention, innovation and change. Through practical experience, learners must be brought to a fuller appreciation of the demands of technological invention. Action-based programs in which female and male students learn to bring together their knowledge, processes, resources and new tools to tackle problems and their solutions are required. Humankind is, after all, essentially a problem-solving species.

But the context of learning about technology and the progress of their society must also include interaction with active business models; economic microcosms of the nation at work. Only then will they become technologically literate and practical.

The real challenge for today's educators is to translate technological concepts into meaningful learning programs that transform our schools and our culture. Such changes have the potential to develop a healthy optimism about the future in communities increasingly dependent upon changing technologies; and particularly, to transform the way the next generation works and thinks.

Peter McGregor

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Career and Technology Studies,
A Curriculum Model

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CAREER AND TECHNOLOGY STUDIES
A CURRICULUM MODEL
BY
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BACKGROUNDER

Throughout the history of what is generally referred to as the Industrial Arts Movement in Alberta, there has been a continuing debate among educationalists on the nature of its content and an appropriately descriptive term for this subject area. From an historical point of view, industrial arts predates Alberta as a province which was awarded provincal status in 1905. During the latter years of its territorial period, manual training was a subject found in the secondary schools. This history of industrial arts as a subject area has evolved through several distinct, but overlapping, periods of development with an associated name change. Changes in the title included:

Manual Training	1900 - 1909
Manual Arts	1919 - 1934
General Shop	1934 - 1945
Technical Electives	1934 - 1945
Industrial Arts	1945 - 1968
Alberta Plan	1962 - 1968
Industrial Education	1969 - 1982
Practical Arts	1977 - 1990
Career and Technology Studies	1990 -

Let me briefly concentrate on the Alberta Plan as a contemporary program that helped to break the link between industrial arts courses that exposed the learner to a very limited number of industrial tools, materials, and processes that proliferated the industrial scene from 1930 to 1960, and a program that de-emphasized the project and introduced the learner to the basic technologies found in a productive society. This four phase program was designed to be taught in a multiple activity laboratory, with Phase I for grade seven students; Phase II for eighth and ninth grade students; Phase III, grade ten students; and Phase IV for eleventh and twelfth grade students. The philosophy of the Plan was to expose both boys and girls to limited psychomotor skills at the awareness level so they could manipulate tools, machines, and processes and develop concepts that were related to the basic technologies.

The unique characteristics of the Alberta Plan that made it a forerunner in its time were: (1) it took its content organizers from technology instead of from industry; (2) it de-emphasized the project and the development of psychomotor skills to the acquisition of concepts; (3) the unit shop learning environment was replaced with the multiple activity laboratory; and (4) it was the most articulated educational program in North America that extended from elementary school through graduate school.

I am sure that the work of Warner and Olson had an influence on Henry Ziel when he developed the conceptual base and the paradigms for the Alberta Plan. Those of us associated with the Plan took the position that neither an industry nor a technology could exist in isolation in a productive society. A productive society was understood to consist of all institutions within Canadian society that provide goods and services for the benefit of its members.

A predecessor term to Career and Technology Studies was the Practical Arts which as an all inclusive term included: Business Education; Home Economics Education; Industrial Arts Education; Vocational Education; Work Experience Education; and the Integrated Occupational Program.

Change Agents

There have been three major change agents in the past decade that have had an impact on curriculum change in the province. These change agents were:

> The globalization of the economies of the nations of the world;
> International, national, and provincial demographics; and
> Technological change.

Time does not permit me to go into any detail on any of these change agents. Let me take the license as speaker to spend some time to discuss the influence that technology had or is having on our thinking as it relates to curriculum change and the way that will prepare students for the transition to either work or higher education in the next century.

Technology As A Change Agent

The only thing permanent in society is change, what is threatening to us is the unpredictable rate and direction of that change. No segment of society in the world community remains untouched by the influence of change. Changes in technology and in the economy have far-reaching impact on the workplace, the work force, and on education. These changes will create worker displacement, temporary unemployment, needed preparation for future occupations and place new and demanding requirements on education.

Technology has created a "permanent skill revolution" that will require that workers develop a different set of skills rather than become proficient in the skills they already possess. In specialized trades, workers will need frequent re-training to keep up with technical developments.

In the resource sector, manufacturing and many service industries, there will be a shift towards more technically sophisticated equipment and more highly skilled employees. Manufacturers will adapt new production processes such as flexible manufacturing, participative management, sophisticated quality controls, customer service, just-in-time production and custom designed production. The workplace is changing and so are the skills that employees must have in order to change with it. The boundaries between many traditional jobs will be eliminated and the worker will have to have multiple skills to perform these jobs. Technology will change the skills required by employees in almost all occupations.

We all know that there have been shifts in the work force and dislocation among industrial workers. Programmable, automated manufacturing technologies such as CAD, CAM, CNC, CIM, robotics/automation have taken former jobs and presented workers with new ones that some are unprepared to handle. Manipulative skills that were required in the past are no longer required.

Employers want employees who have learned how to learn, which is the basis for all skills. Equipped with this skill an individual can achieve competency in all other basic workplace skills from reading through leadership. An employee who knows how to learn is more cost-effective because time and resources spent on training can be reduced.

Many employers say that the most important skills for any employee are the academic "Triumvirate" - reading, writing and computation. Although these skills are important and widely used in industry, because of new technologies and organization of the work environment, employers complain that graduates of the educational system have serious deficiencies in these areas:

Problem Solving
Personal Management
Interpersonal Skills
and the abilities to:
Conceptualize
Organize
Verbalize Thoughts
Resolve Conflicts and
Work in Teams.

The new workplace basic skills.

Information technologies are creating similar change in the automated office. In this environment higher-level literacy is required for most workers in this sector.

Educational leaders across Canada are saying that the mass education approach that was designed to turn out productive workers during the last three decades is no longer appropriate. This has been part of the move toward equity and excellence in education in North America.

Several reports were released in the United States at the beginning of the 1980's which supported the assumption that the way to achieve excellence in secondary education was to increase the academic credit requirements for graduation. Most notable among these reports was A Nation At Risk (1983).

Canada has not had the benefit of any national studies that have reviewed secondary education. Education as a provincial responsibility caused a number of ministers of education, about the time of the national studies of secondary education in the United States were being conducted, to commission reviews of secondary education in their provinces. In February 1984, the Minister of Education, the Honourable David King, initiated a review of Alberta's Secondary Education Program. The mandate given to the Advisory

Committee was to assess the Secondary School Program available to Alberta students and to provide direction for future changes (Review of Secondary Programs, n.d., p. 1). To fill its mandate, the committee initiated several data collecting activities:

> Solicited opinions and comments from the public.
> Discussion papers were prepared and circulated.
> Questionnaires were distributed.
> Meetings were held with professionals (Alberta's Secondary Education Program: The Public's View. n.d., pp. 1-2).

These activities taken together resulted in a policy statement Secondary Education in Alberta, June 1985, which is the position of the provincial government regarding the future of secondary education in the province. The policy is part of a comprehensive approach to equity and excellence in education. It provides a framework for structuring and improving the instructional programs of secondary schools (Secondary Education Action Plan, 1986, p. 1). The new instructional program was designed to consist of core courses, the academic basics, and complementary courses, optional courses, including the Practical Arts, the fine arts, second languages and computers.

Since the implementation of the policy statement in 1988, there has been a continuous erosion of the number of credits devoted to the complementary courses. Today, of the hundred credits required for a high school diploma, seventy-two are devoted to core courses and the remaining twenty-eight are reserved for complementary courses. This resulted in the students taking more courses in traditional subjects by re-emphasizing the academic basics. These added course requirements placed additional pressures on the 30% of students who leave school earlier than anticipated.

Practical Arts Review

As a result of declining enrollments in the Practical Arts, major school boards throughout the province began an independent review of the Practical Arts. The Calgary Public Board of Education began its review of the Practical Arts in the Fall of 1987 which evolved into a task force study. The Edmonton Public Board of Education soon followed with its review. In September 1988 the Department of Education began the provincial Review of the Practical Arts. The review involved over 200 courses in junior and senior high school Business Education, Home Economics, Industrial and Vocational Education and Work Experience Education programs (Alberta Education, 1990, Framework for Change: Career and Technology Studies in Secondary Schools In Alberta, p.1) and was conducted in two phases. Phase I was to establish directions for change in the Practical Arts for the next decade. To determine that direction, an extensive information base was established which included research of literature, analysis of related curricular initiatives and trends in programs within and outside of Alberta, and audit of present programs. Numerous stakeholder groups representing the educational community, personnel of Alberta Education, other departments within the provincial government, post secondary education, and business, industry and labour were encouraged to provide input and offer advice and, in as much as possible, encouraged to interact. Input was received through committee meetings, interaction at workshops, seminars, and conferences and through formal submissions (Alberta Education, 1990, Career and Technology Studies: A Vison For Alberta's Secondary Practical Arts Program, p. 6). From that effort two foundational documents were prepared: Vision for Alberta's Secondary Practical Arts Programs and Framework for Change. The latter document provides the philosophy and the basis for future curriculum development for the new program.

CTS - Curriculum Model

Career and Technology Studies (CTS) was the title selected for the new program. **Career** *is defined as the sum total of a person's paid and unpaid life experiences.* **Technology** *is defined as the technical means to attain human purposes.*

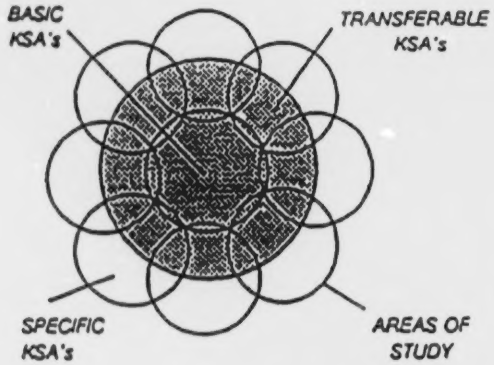
The philosophical foundation for CTS is to "help students manage technology efficiently and effectively and to develop knowledges, skills, and attitudes to meet with confidence the challenges of daily living and the world of work" (Alberta Education, Career and Technology Studies: Building for the Future, 1991, p. 2). To attain this philosophy the program that is being designed will be flexible to provide challenging learning experience for each student; to provide opportunities for individualized learning; makes good use of new technology; and generally reflect the realities of the fast changing world community. Flexibility will be achieved through appropriate student timetabling, use of community resources in the form of community partnerships, and adapting according to funds and equipment that is available.

The curriculum structure for CTS will keep key principles of the present Practical Arts programs that will be organized into eight Areas of Study and into twenty seven

Strands/Courses. An **Area of Study** is the grouping of a number of strands that are related through similarity of basic and transferable skills, knowledge, and attitudes, similar environments, clientele or products, prepares students for a broad range of careers in personal life and work life. **Strands** are the grouping of modules within a career area that have related knowledge, skills, and attitudes (KSA's). The base of the new curriculum will be on modules of instruction that have clearly-stated expectations regarding students' competencies upon entry and exit. The modules will be designed to fit into specific courses, for example, Building Construction, but some, like a module on safety, would apply throughout other courses that make up the program. In such a case, students who had mastered the safety module would not take it again, even though they moved into another area of study. Modules will be designed that will consist of twenty-five hours of instructional time. There will be both foundation and experience modules. Each will include required and elective learning expectations. The major part of the required content of the module will contain the knowledge, skills, and attitudes that all students should be expected to acquire in order to function effectively in society. The elective component of each module will provide opportunities for enrichment, reinforcement, innovation, and experimentation within individual schools.

The following model best illustrates the relationship of the basic knowledge, skills, and attitudes (KSA's) that are essential to the Strand and Area of Study. It is possible that students may bring many of these KSA's from previous schooling of a personal background. Some of these KSA's are transferable to the eight Areas of Study. The CTS program will concentrate on students' competencies, which are often transferable from one career area to another.

CURRICULUM MODEL



Taken from: Career and Technology Studies Building for the Future

Transferable skills is a synonym for generic skills. De W. Smith (1973) defines generic skills as "those overt and covert behaviours which are fundamental to the performance of many tasks and sub-tasks carried out in a wide range of occupations and which are basic to both specialized application and job specific skills" (p. 1). These skills can be categorized as cognitive transferable skills or psychomotor transferable skills.

Cognitive Transferable Skills

Communication
Reading
Writing
Listening
Conversing

Science
Physics
Biology
Chemistry

Mathematics
Arithmetic
Geometric Figures
Intermediate Mathematics

Reasoning
Estimating
Sort/Classify
Obtain Job Related
Information
Work Task

Transferable competencies will be applicable to two or more Areas of Study. These will be acquired and emphasized in introductory courses and reinforced and expanded in intermediate and advanced level courses.

Most of the instruction will be process-oriented and "hands-on". Instruction may take place in a school but may also occur on the premises of a community partner-local business, industry or community agency. The style of instruction will vary according to need: it will include independent study, computer-managed learning, small group activities as well as traditional classroom groups.

To design and implement CTS Curriculum a number of strategies will be used by the Curriculum Branch. These strategies might include focus groups located throughout the province; contracts with individuals; contracts with school systems; or the purchase of programs that were developed elsewhere with the right to modify (Alberta Education, Career and Technology Studies: Building For the Future, 91-09-27, p. 2). Presently, the Curriculum Branch has under contract, school districts and individuals who are conducting pre-development projects for a number of Areas of Study. The final draft of these projects will show the scope and sequence for the Strand/Course. Curriculum implementation will be phased in from 1992 to 1996. Presently, Tourism and Enterprise and Innovation are being pilot-tested in a number of schools throughout the province.

The focus of the CTS program is for the learner to develop technological awareness that is based on concepts that provide students with the critical knowledge, skills, and attitudes to help prepare for a lifetime of problem solving and decision making for a world that is undergoing continuous change.

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Vocational and Technical Education at Secondary Schools in Taiwan, ROC

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International Technological Literacy Symposium

Vocational and Technical Education at Secondary Schools in Taiwan, Republic of China

Presented

by

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VOCATIONAL AND TECHNICAL EDUCATION AT SECONDARY SCHOOLS IN TAIWAN, REPUBLIC OF CHINA

INTRODUCTION

Taiwan has progressed from an agricultural society in the 1950's and 1960's to an industrial labor-intensive developing nation in the 1970's and early 1980's. Today, Taiwan is one of the economically fastest growing nations in the international economy and marketplace. Beginning in 1973, the government of the Republic of China in Taiwan has launched a series of five-year industrial and economic development plans to upgrade and update its workforce. This year, the Taiwan government has initiated yet another ambitious six-year $300 billion dollar national development plan to prepare the nation for the 21st century. None of these would have been possible if the engineering and technology education for its workforce was neither in place nor implemented.

In "Taiwan's Polytechnical Educational System", Chen (1990) pointed out that "Taiwan, like many other nations, views engineering and technology education as a key to acquire and maintain a new technological advantage and is certainly taking this issue very seriously" (p.5). Taiwan's policy on education has been proactive, progressive and constantly changing. The overall educational programs in engineering and technology education in particular, have been carefully planned and developed over the past thirty years to meet the demand and challenge.

EDUCATIONAL SYSTEM

The K-12 educational system in Taiwan is largely based on the American model of education, the six-three-three system. Students attend six years of elementary school and three years of junior high school, thereby completing the compulsory nine years of obligatory education. This nine-year compulsory education has been implemented since 1968.

According to Bureau of Statistics, Ministry of Education (1991), there were originally three categories of secondary education: academic high school (junior, senior), normal high school, and vocational high school (junior, senior), as illustrated in Figure 1.

Since the implementation in 1968 of nine-year compulsory education, normal high schools have been upgraded to junior colleges in 1971 and further to four-year universities in 1987 to raise the quality of elementary school teachers. Vocational junior high schools have been abolished (p.11).

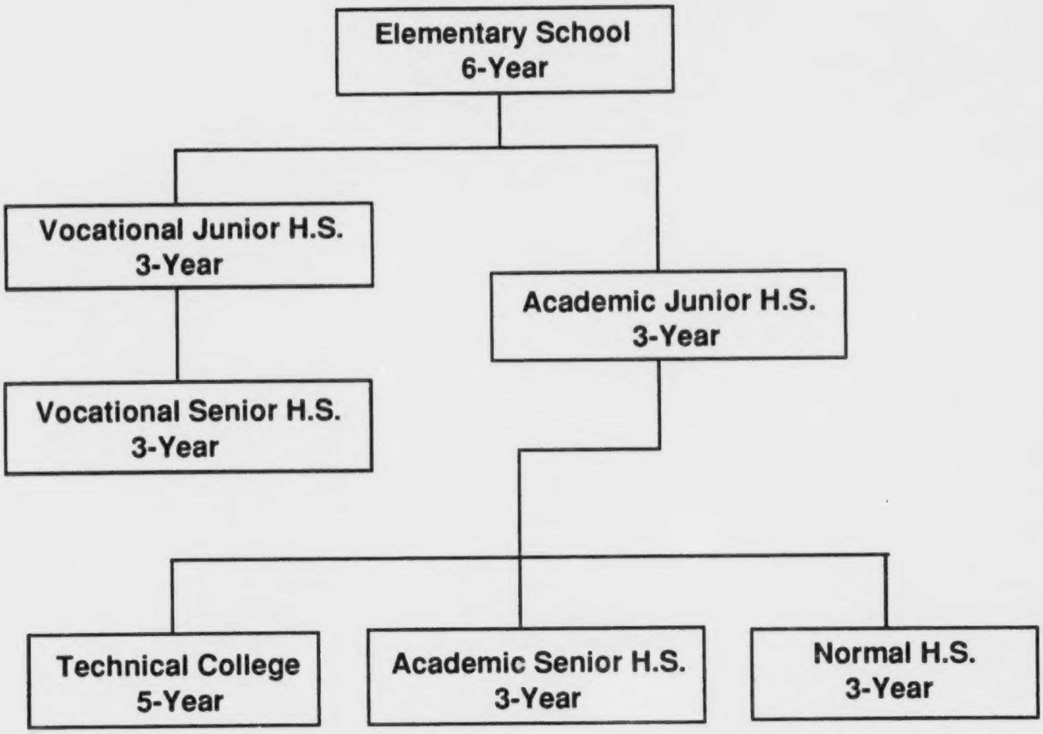
Elementary School 6-Year
Vocational Junior H.S. 3-Year
Academic Junior H.S. 3-Year
Vocational Senior H.S. 3-Year
Technical College 5-Year
Academic Senior H.S. 3-Year
Normal H.S. 3-Year

Figure 1. Taiwan's k-12 Educational System Before 1968.

SECONDARY VOCATIONAL/TECHNICAL EDUCATION

In 1990, more than eighty percent (84.7%) of junior high graduates chose to continue their education (Bureau of Statistics, 1991, p.40). They had three options: (1) an academic high school, (2) a vocational/technical senior high school, or (3) five-year technical college. In each of these three options, a joint entrance examination was required to determine which school a student is to attend. Figure 2 illustrates a student's course of study from elementary school to secondary school.

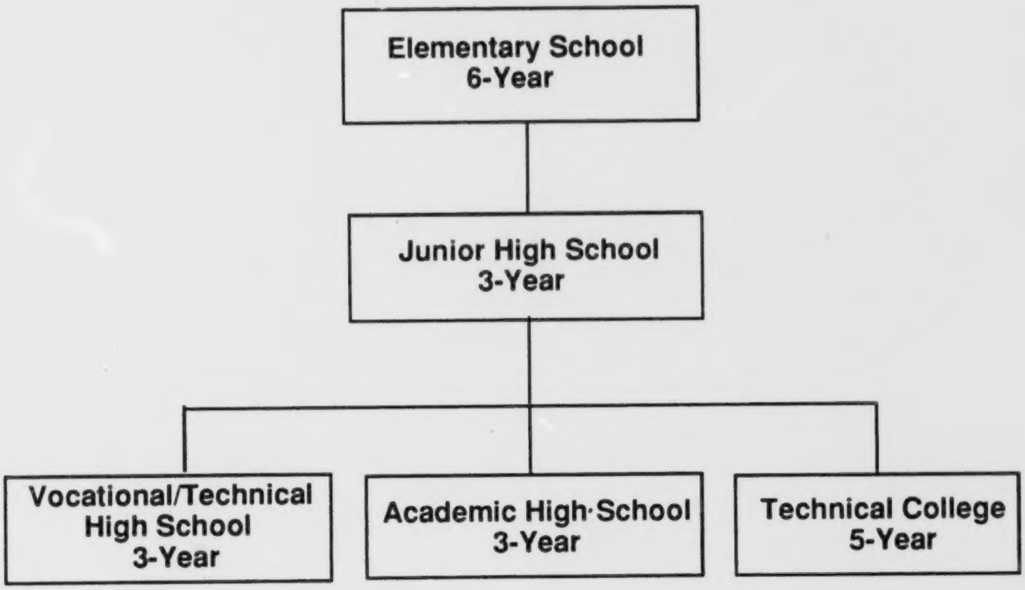
Elementary School 6-Year
Junior High School 3-Year
Vocational/Technical High School 3-Year
Academic High School 3-Year
Technical College 5-Year

Figure 2. Current Taiwan's k-12 Educational System

[A] ACADEMIC SENIOR HIGH SCHOOLS

Traditionally, all academic high schools offered no or little technology courses of technical training programs to these students. More and more of these academic high schools are now experimenting curriculum change study by offering vocational/technology education courses to prepare those less- or non-college bound high schools seniors for pre-occupational skills. A combination of three different courses in two types of occupation can be offered at each academic high school (Chen, 1989, p.6). As of the 1990-91 school year, there were a total of 170 academic high schools with 46.5% being public and 53.5% private. Almost half (47.6%) of these academic high schools offered vocational/ technology education courses or programs (Bureau of Statistics, 1991, p.11). These high schools are similar in curriculum to comprehensive high schools, a popular educational model in the United States. See Table 1.

Table 1
Academic Senior High Schools in Taiwan

	No. of H. S.		Types of High Schools			
			Academic		Comprehensive	
Public	79	46.5%	60	35.3%	19	11.2%
Private	91	53.5%	29	17.1%	62	36.4%
TOTAL	170	100.0%	89	52.4%	81	47.6%

[B] VOCATIONAL/TECHNICAL SENIOR HIGH SCHOOLS

As the country became more technologically-oriented, the number of students selecting vocational/technical high schools and five-year technical colleges increased dramatically. In 1990, according to Bureau of Statistics (1991, p.14), there were 216 vocational/technical high schools serving nearly 450,000 students. The average class size in these schools has increased from 44.35 in 1976 to 45.38 in 1990 (P.36). The secondary vocational/technical high schools come in seven different categories: agricultural, industrial, commercial, marine products, nursing-midwifery, home economics, and theater arts (Republic of China Yearbook, 1991, p.367). Table 2 illustrates the distribution of these schools. As shown in Table 2, industrial and industrial-Commercial schools accounted for 56% (120 schools).

Table 2

Vocational/Technical High Schools in Taiwan

Types of Schools	No.	Public		Private	
Agricultural	6	6	2.8%	--	0%
Agri-Industrial	18	18	8.3%	--	0%
Industrial	31	25	11.6%	6	2.8%
Commercial	22	16	7.4%	6	2.8%
Industr./Comm.	71	12	5.6%	59	27.3%
Marine Products	7	6	2.8%	1	0.4%
Nursing/Midwifery	13	2	0.9%	11	5.1%
Home Economics	45	9	4.2%	36	16.7%
Drama/Arts	3	1	0.4%	2	0.9%
TOTAL	216	95	44.0%	121	56.0%

Table 3 lists a three-year electronics technology program curriculum for vocational/technical high school (Ministry of Education, 1986, pp.36-39). The students are required to complete at least 222 semester hours for graduation. The program consists of 34.2% (76 hours) of humanities and social sciences, 13.5% (30 hours) of basic mathematics and sciences, 28.9% (64 hours) of vocational/technical courses including technical electives, and 23.4% (52 hours) of shop practice.

Table 3

Electronics Technology Curriculum for Three-Year Vocational/Technical High School

First Year	Ist Semester	2nd Semester
Chinese	4	4
English	2	2
Music/Arts	1	1
Physical Education	1	1
Military Training	2	2
Int. to Social Sciences	2	2
Mathematics *	4	4
Physics	3	3
Basic Electricity	3	3
Graphics	3	0
Int. to Mechanism	0	3
Electronics I & II	2	2
Industrial Funda. Practice	8	8
Weekly Session	1	1
Group Activity	1	1
TOTAL	37	37

* Algebra and Geometry

Table 3 (continued)

Second Year	Ist Semester	2nd Semester
Chinese	3	3
English	2	2
Physical Education	1	1
Military Training	2	2
Int. to Social Sciences	2	2
Mathematics **	4	4
Chemistry	2	2
Int. to Computer	2	2
Electronics III & IV	3	3
Digital Electronics I & II	3	3
Electronics Instrumentation	3	3
Electronics Practice	8	8
Weekly Session	1	1
Group Activity	1	1
TOTAL	37	37

** Trigonometry and Pre-Calculus

Third Year	Ist Semester	2nd Semester
Chinese	3	3
English	2	2
Physical Education	1	1
Military Training	2	2
Thoughts of Dr. Sun Yat-Sen	2	2
Principles of Television	3	0
Sensors	3	0
Electrical Mathematics	3	0
Industrial Electronics Circuits	0	4
Electronics Practice	10	10

Table 3 (continued)

Third Year	Ist Semester	2nd Semester
Technical Electives	6	11
Weekly Session	1	1
Group Activity	1	1
TOTAL	37	37

[C] FIVE-YEAR TECHNICAL COLLEGES

In 1990, there were 75 technical colleges which offered two-year, three-year, and five-year engineering technology diploma programs. Nearly 70% (69.3%) of these colleges offered five-year and two-year programs as shown in Table 4. Started in 1989, the Ministry of Education decided to phase out the three-year programs due to its overlapping curriculum with the regular four-year baccalaureate engineering programs.

Table 4
Technical Colleges in Taiwan

Types of Schools	No.	Public		Private	
Two-Year	10	0	0%	10	13.3%
Three-Year	1	1	1.3%	0	0%
Five-Year	4	1	1.3%	3	4%
Two- & Five-Year	52	6	8%	46	61.3%
Two- & Three-Year	1	1	1.3%	0	0%
Three- & Five-Year	5	3	4%	2	2.6%
Two-, Three-, Five-Yr	2	1	1.3%	1	1.3%
TOTAL	75	13	17.3%	62	82.7%

To meet the demand for skilled technicians, not only the number of vocational/technical colleges has been steadily increased in the past decade, but also the nature of the curricula has been changed more toward technology. There have been more application-oriented technology courses, more applied technical classes, and less mathematics, science, and advanced engineering classes for both five-year and two-year programs. The missions between these two programs are slightly different. The five-year technical program is designed to produce more balanced, all-around technologists while the two-year technical program is designed to provide technologists with more hands-on application-oriented training.

Table 5 lists a five-year mechanical engineering program with a manufacturing concentration (Chen, 1990, P.7). The students are required to complete at least 232 semester hours for graduation. The program consists of 56% (130 hours) of technological courses including technical sciences, technical specialties, and technical electives, 18% (42 hours) of basic sciences and mathematics, and 26% (60 hours) of humanities and social sciences.

Table 5

Curriculum for Five-Year
Mechanical Engineering Program/Manufacturing Concentration

First Year	Ist Semester	2nd Semester
Chinese	4	4
English	3	3
Modern History of China	2	2
Geography of China	2	2
Civics	2	2
Mathematics+	5	5
Chemistry & Lab.	4	4
Graphics	2	2
Shop Practice	1	1
TOTAL	24	24

Table 5 (continued)

Second Year	Ist Semester	2nd Semester
Chinese	3	3
English	3	3
Mathematics++	5	5
Physics & Lab.	6	6
Graphics	2	2
Mechanical Materials	4	0
Applied Mechanics	0	4
Mechanicals Processes	2	2
Shop Practice	1	1
TOTAL	26	26

Third Year	Ist Semester	2nd Semester
Chinese	3	3
English	3	3
Computer Programming	2	0
Mechanics of Materials	3	3
Mechanism	2	2
Electrical Engineering	3	0
Electrical Engineering Lab.	0	1
Shop Practice	1	2
Process of Plastic Deformation*	3	0
Foundry*	3	0
Machine Graphics	2	2
Electronics	0	3
TOTAL	25	19

Table 5 (continued)

Fourth Year	Ist Semester	2nd Semester
Chinese	2	2
English	2	2
Thoughts of Dr. Sun Yat-Sen	2	2
Machine Design 1	4	0
Shop Practice	2	2
Material Testing	0	1
Machine Tools*	0	1
Precision Gaging*	0	3
Cutting Tools*	0	2
Machine Design 2*	0	4
Machine Graphics*	2	2
Int. to Thermodynamics	3	0
Int. to Fluid Mechanics	0	3
Electronics Lab.*	1	0
Heat Engines*	0	2
Welding*	3	0
Jigs & Fixtures*	3	0
TOTAL	24	29

Fifth Year	Ist Semester	2nd Semester
Factory Management	2	0
Quality Control	0	2
Heat Treatment*	3	0
Surface Treatment*	0	3
Machine Design Drawing*	2	2
Solid & Fluid Mechanics Lab.*	1	1
Fluid Power & Lab.*	3	1

Table 5 (continued)

Fifth Year	Ist Semester	2nd Semester
Automatic Control*	3	1
Theory of Lubrication*	2	0
Heat Engines*	3	0
Fluid Machinery*	3	0
N C Machine & Shop*	2	1
Tool Design	2	0
TOTAL	23	13

Electives	Ist Semester	2nd Semester
2nd Foreign Language	4	0
Production Control	0	3
Engineering Economics	0	3
Factory Layout	0	2
Microprocessor	0	3
Measurements	0	3
Energy Conversion	0	2

+ Includes Trigonometry & Analytic Geometry and Algebra

++ Calculus

* Select any combined 56 credit hours from the group.

SUMMARY

Secondary technology education has come a long way. Vocational and technical schools in the past were considered to be the "shelters" for those students who were filtered out by the fierce, highly competitive joint entrance examination and those who were not college-inspired. Today, almost seven out of every ten students choose to enter secondary vocational/technical schools or five-year technical colleges. The situation in Taiwan's educational system has always been demand far exceeding supply, i.e. not enough schools for all the students. Over the years, the government has engaged in a series of aggressive, innovative changes to coincide with the industrial and economic development plans to improve its people's quality of life.

Industrial expansion, information explosion, and the increasing complexity of advanced technology, as experienced by other industrialized nations, underlie the anticipated increase in demand for professionals and skilled workforce. The secondary technology education is undergoing an unprecedented process of changes to meet the challenge and demand.

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Blueprint for Literacy in Technology (BLT)

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BLUEPRINT for LITERACY in TECHNOLOGY (BLT)

by

Jerry Balistreri*

Douglas Hammer*

An exciting opportunity was provided for persons or groups to receive assistance through the United States Department of Education grant to develop programs for teaching technological literacy. In response to the need for exemplary programs to prepare students for life in a technologically changing world, the University of Alaska Anchorage (UAA) and Anchorage School District (ASD) proposed to develop a "Blueprint for Literacy in Technology" (BLT).

The impetus behind this effort had its roots in a search of the literature which attempted to secure how experts around the world defined technological literacy. Using the Dialog Information Retrieval System, the following seven data bases were used in the literature search:

- Biotechnology Abstracts
- Current Technology
- Energy Science and Technology
- Japan Technology Plus
- Scisearch
- Soviet Science and Technology
- Supertech

Each data base was provided the descriptors of: technology define, literacy define, technological literacy define, etc. The results of such a search yielded over 300 definitions. After a review of each definition it was noticed that several items tended to surface and resurface throughout many of the definitions. Five common items surfaced and were noted which became the driver for curriculum development of a new senior high level course entitled "Introduction to Technological Literacy." The five common items became unit headings for this course which will be described in greater detail later in this report by Mr. Donald Bernard. The impact of change and the new developments in technologies that facilitate our quality of life provided essential elements in the proposed curriculum. The purpose of the proposed project was to develop a model program to provide experiences in technological literacy to secondary students. Critical elements included:

- cooperation between a teacher preparation institution and public school personnel;
- multi-discipline staff training for the technology teachers, counselors, administrators and teachers of other related disciplines;
- close involvement of business and industry throughout the project both in advisory roles and as participants in the training of the students;
- the development of a curriculum that provides student experiences to develop technological literacy;
- replication of the developed program to other sites;
- a culminating institute to involve local, statewide, national and international technology educators in validating and disseminating the project outcomes.

Throughout the activity a synergism among the participants has provided enthusiasm and energy as new strategies and content have developed. An excellent opportunity for interested individuals to observe, participate and ask questions has provided a valuable resource for Alaska. Students at the University of Alaska Anchorage have been able to participate in developing activities, student teaching and observing the success of the program. Other vocational teacher education workshops and classes have visited and participated in activities to better understand the scope and process of teaching technological literacy. One method of assisting the change transition is to provide a quality model for a base. An important part is the inservice activities where perspective instructors, counselors, and administrators can learn the strategies and content. Quality instructors who demonstrate a commitment and enthusiasm are essential. Finally the facility, equipment and curriculum materials must be available and of sufficient quality to facilitate the process. Each of these components has been developed and provided as a critical element of the BLT project.

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CRITICAL TECHNOLOGIES FOR ECONOMIC GROWTH

Harry Armen*

INTRODUCTION

> *"We believe that the erosion of competitiveness is a serious problem for this nation-one of the most severe that it faces as it prepares to enter the 21st century."*
>
> Competitiveness Policy Council. Annual Report to the President & Congress. Building a Competitive America. March 1992

Historical Perspective

In November 1991, the U.S. House of Representatives-in a bipartisan "sense of the House" resolution-went on record in favor of a comprehensive, coordinated competitiveness strategy for the United States:

Resolved. That it is the sense of the House of Representatives that-

> (1) There is a need for the development of a comprehensive, coordinated strategy to encourage investment in human and material resources, to harness our inventive genius to the marketplace, to secure the education and training of a competitive citizenry and work-force and to stimulate cooperative efforts between the private and public sectors at all levels of business, education, and government; and
>
> (2) such a comprehensive, coordinated strategy will help the United States achieve its goal of being the strongest nation on earth economically and militarily, so that it remains the greatest nation in support of human dignity, freedom and democratic ideals.

---

*Corporate Technical Advisor, Grumman Corporation, American Society of Mechanical Engineers Congressional Fellow, 1991 Serving on the Legislative Staff of Senator Jeff Bingaman (D-NM), External Evaluator, *Blueprint for Literacy in Technology*

The international competitiveness challenges facing the U.S. today can be placed in an historical perspective. The clearest analogy available is Great Britain a century ago. By the end of the the 19th century and the beginning of this century it was clear to virtually everyone that Great Britain had been the world leader in engineering, in technology innovation, and the application of technology to achieve preeminence as an industrial power in manufacturing.

A few of the areas in which Great Britain was a leader are:

-The construction of railroads

-Development of the steam engine

-Major advances in bridge construction

-Development of ocean liners and great warships of the era

-Development and manufacture of the threshing machine

-Textile manufacturing

-Development of the steel and the aluminum industry.

There are many reasons why Britain was unable to maintain its preeminence as a technologically superior nation. An excellent account of some of these reasons appears in Reference [1].

> *"Economists have pointed out that Britain failed to adapt adequately to changing circumstances. In the traditional sectors British businesses were often not as efficient and productive as those of their competitors; in the new ones the British did not innovate as rapidly or as effectively. In part the nation's businessmen were suffering the consequences of having "gone first"; they had a heavy investment in plants, equipment, and techniques were being made obsolete by developments in the more recently industrialized nations...."*

Finally and most significantly...

> *"...for reasons that seem to lie deep in their culture, there was a certain distaste for education that was not strictly classical, for business and industry as a whole, and for*

the appearance of excessive effort, planning, or professionalism."

The U.S. has enjoyed technological dominance for most of the 20th century. It is the place where most progress has been made in:

-Aerospace
-Atomic Energy
-Telephones and Communications Technology
-Computers and Software
-Semiconductors
-Biotechnology
-Advanced Materials, for example.

The U.S. has been able to lead the world in science and technology and engineering for at least three key reasons:

(1) strong government support of basic sciences

(2) U.S. industry benefitting from spinoffs from government investment in technology development and application

(3) our universities have been beacons, attracting the world's best science and engineering talent, and have been the world's center for technological breakthroughs.

The significant question to be addressed is --Which nation will provide the technological leadership in the 21st century? As we approach the 21st century, we need to recognize the significance of the globalization of technology, the interdependence of world economies, and the need for a technologically literate work-force. A work-force capable of applying new technologies to every sector of our gross domestic product is one of the key determinants to our economic strength.

We need to recognize that old paradigms which shaped our economic well policies of the past are giving way to new ones. Land mass, natural resources, military power and population size have been supplanted by technology, human resources, stable political environments and capital investments, respectively.

PROBLEMS. TRENDS AND CAUSES

Problems

The central problem we have had for almost two decades is one of a stagnant economy. A stagnant economy means:

-Stagnant wage rates
-A lowered standard of living
-Fewer opportunities for successive generations.

A significant manifestations of this central problem is the loss of technological leadership.

A related problem facing the U.S. is the myopic vision with which we view our public an private sector investments in our human resources. Robert Reich, the noted economist points out that corporate America talks a good game about "partnerships" between corporations and schools. The notion that the private sector is taking, or will take substantial responsibility for investing in America's work-force is dismissed as misleading by Professor. Reich, Reference [2].

> *"The rate of corporations giving to American education declined markedly in the economically robust 1980s. In the 1970s through the start of the 1980s, corporate giving to education climbed an average of 15 percent a year. But in 1990, corporate giving was only 5 percent more than in 1989."*

Most of the money never finds its way to the public primary and secondary schools anyway. Of the $2.6 billion that corporations contributed to education in 1989, only $156 million went to support public schools. The remainder went to private schools or to colleges and universities -- worthy institutions, but few of tomorrow's first-line workers will receive their education in them.

Training is another area where we have fallen down. Of the $30 billion that the private sector spends annually to train employees, only a fraction goes to the first-line worker. No more than 8 percent of U.S. firms provide remedial classes in reading, writing or mathematics. Most of the training is spent on high-level managers. Employees with college degrees are 50 percent more likely to receive corporate training than are non-graduates; executives with postgraduate degrees, twice as likely to get training as those with college degrees.

American industry, particularly the small to medium sized manufacturer employing less than 500 employees, has great difficulty adopting new technologies that yield higher productivity, dependable quality, shorter product cycle times and less waste. We have blamed this situation on the lack of a skills shortage in our work-force. The report of the commission cited in Reference [3], concluded that in truth there was no skills shortage of our work-force. Study teams, sent into the field to determine how employers were using their workers, found that

> *"Few of these firms are worried about skills."*

Most disturbing was the observation that,

> *"...there was the lack of any expectation among the majority of employers that their skill requirements would be changing...Only five percent are concerned about growing educational skill needs."*

Two conclusions can be drawn from these observations. The first conclusion is, given the way tasks are organized in most companies in the U.S., worker's skills are not important. Most companies still follow the principles set forth 90 years ago by Fredrick Taylor--to break down all processes into simple tasks which could be performed by rote.

Another conclusion is that corporate America is not worried about the future of the American work-force. Why? One reason is that U.S. corporations are finding the workers they need outside the country, often at a fraction of the price. Multinational American firms are not new, of course. What is new is that growing percentage of their employees are foreign and export much of what they make back to the U.S.

Reference [3] has made it clear that as a nation we are extraordinarily lax in providing for the productive and systematic introduction of our non-college youth into the world of work. The problem, of course, does not start at the time a student graduates from high school. It starts at a much earlier age, when there is little to motivate many youngsters to perform at their highest level throughout their educational experience, since there seems to be no connection between educational achievement and the likelihood of getting a job.

Finally, we have become a nation of consumers rather than a nation of producers. We have been moving from a manufacturing-based economy to a service based economy, while our economic rivals have continued to emphasize the education, development and application of technology, particularly in manufacturing. We no longer focus on creating wealth through manufacturing.

Given the problems that are in evidence, and given the policies that we are continuing to follow we will give up our world leadership in technology utilization and our industrial and economic strength that goes with technological leadership in manufacturing. Just as the British lost their preeminent position in engineering and technology at the end of the 19th century, we are in danger of losing our preeminent position as we approach the end of this century.

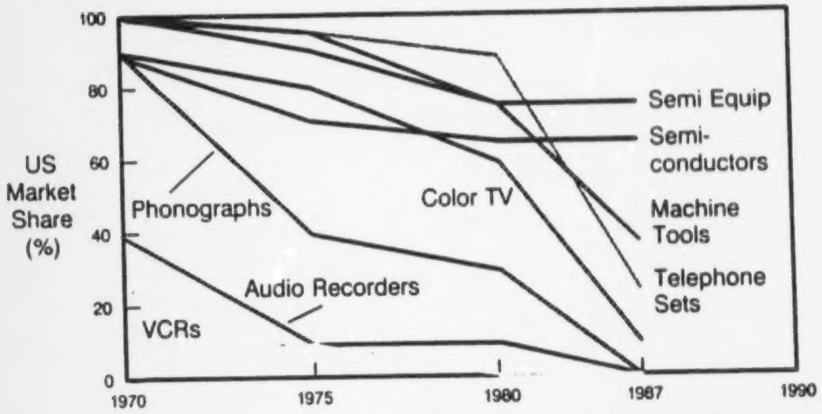
The Competitiveness Policy Council, made up of representatives from industry, government, labor and public interest organizations, summarized our nation's current dilemma with the following observation made in their most recent report. Reference [4].

> *"Based on our present policies and performance, the U.S. is condemned to slower growth than the other main industrial countries for the foreseeable future."*

Trends

Figure (1) is a chart that shows the erosion of U.S. world market share in technology markets. The data for these trends were obtained from a report from the private sector Council on Competitiveness, Reference [5]. All of the products listed on the chart were invented in the U.S. It is evident from the trends that we have not been able to sustain a market share in these high value-added manufacturing products.

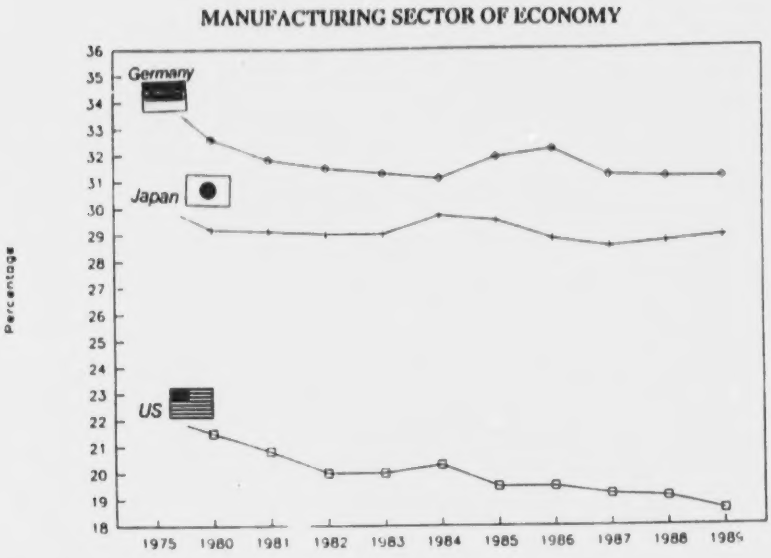
Erosion of US Share of Technology Markets



Source: Council on Competitiveness "Picking Up The Pace" September 1988

Figure 1

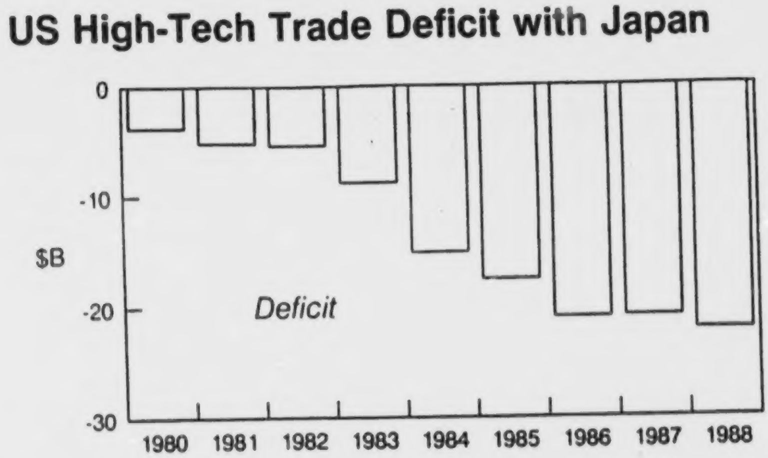
Another disturbing trend is shown on figure (2). There has been a steady decline of manufacturing, the generator of wealth, as percentage of GNP in the U.S. for several decades. This decline is greater in absolute terms and in relative terms when compared with Japan and the Federal Republic of Germany.



Actual Values
Sources: US-DOC, BEA (GNP)
Japan & FR Germany-U.N. Nat Accts Stat(GDP)

Figure 2

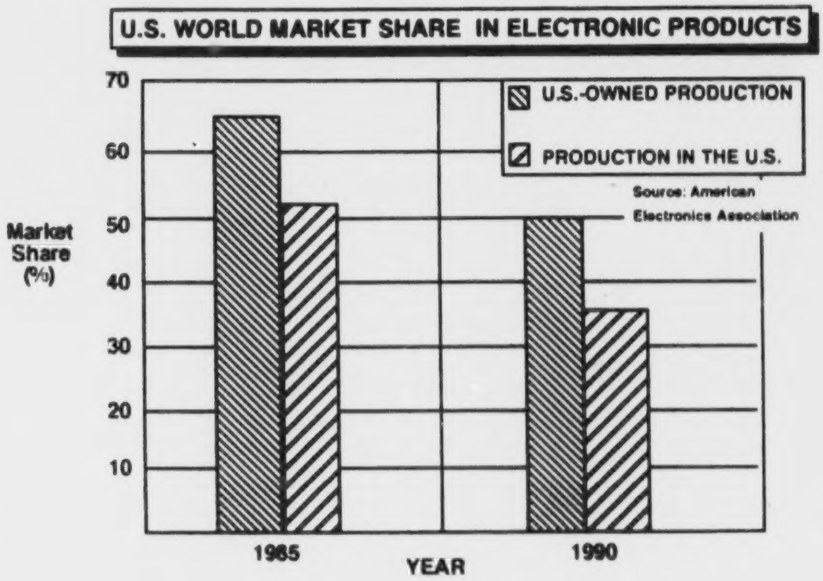
Some economists would argue that the decline of manufacturing as function of our economy is not significant because it is primarily the result of our increased productivity in the manufacturing sector. However, it is important to note how well we are doing in the manufacturing of high value-added items, relative to our economic competitors. This is indicated in figure (3), which charts the growth of the U.S. trade deficit with Japan in high-technology items. The deficit has grown from $3.8 billion in 1980 to $22.1 billion in 1988. In light of the once again exploding Japanese trade surplus, over $90 billion in Japan's fiscal year 1992 according to a recent report, this problem probably has not gotten any better despite the narrowing of our trade deficit in recent years. The situation is further exacerbated by the fact that the U.S. companies last significant market share during this period, while the Japanese maintained more than 93 percent of their home market in high-technology products.



Source: US Dept. of Commerce International Trade Administration Office of Trade and Invest. Analysis

Figure 3

Finally, figure (4) shows the loss of U.S. world market share in electronic products from the period 1985 versus 1990. According to the National Advisory Committee on Semiconductors, U.S. electronics firms have lost 14 percent of world market share over the five year interval. This is equivalent to more than $100 billion in lost revenue.



Source: American Electronics Association

Figure 4

Causes of Problems and Adverse Trends

The trends on the previous charts are the direct result of apathy, inertia, and a steadfast belief of some ideological myths. Apathy is evident when there is denial about the previously mentioned problems, about the loss of our industrial capacity in high-technology manufacturing sectors of our economy, and about our human resources.

Inertia come from the belief that we must not deviate from the way we have functioned in the past, despite the fact that the world have experienced some rather dramatic change. There is also inertia in our adoption of new technologies. Many of the U.S. manufactures are slow to adopt new technologies. The National Center for Manufacturing Sciences has stated that it takes approximately 55 years for 90 percent of U.S. manufactures to adopt a new technology. In Japan, on the other hand, it takes only 18 years.

Our leaders in the private sector have adopted a set of blinders that prevent them from seeing beyond the next quarterly financial statement. There is little long-term strategic technological planning and investment. Some of our leaders in government have installed a set of ideological blinders which force them to conclude that the previously mentioned problems are not those the public sector should be involved with. They have come to believe that these are problems for the private sector to solve alone, an outmoded laissez-faire doctrine no other country follows religiously.

These ideological myths lead one to conclude that government should stay out of the process of helping industry develop and apply technologies--although other governments don't share that belief. It also leads to misleading conclusions that we need not be concerned about the size of our trade deficit, and that the make-up of the trade deficit does not matter.

In many cases we are working on assumptions that are not valid. Assumptions such as:

- The relationship between scientific knowledge, superior technology, engineering innovation and competitive products is linear.
- Investment in discovery alone leads naturally to economic prosperity.
- Spinoffs from defense research and development will continue to provide the innovations for our commercial industrial base.

A direct result of these assumptions and our government policies is that our scientists make the breakthroughs and are awarded the Nobel Prizes, but our competitors are the ones who commercialize the products. Here it is "Publish or Perish," overseas, especially in Japan, it is "Patent or Perish." Here the scientist is revered, there the engineer is. In fact, most of the industrial leaders in Japan, the heads of the large manufacturing enterprises, have engineering backgrounds. Here they are graduates of business and law schools.

While we continue to believe that we can remain the world's leader, technologically, industrially, economically without conscious policies to achieve that, our competitors are doing what any good competitor would do--pursuing strategic plans to gain world leadership in these areas.

WHAT NEEDS TO BE DONE?

An Investment Strategy

There are at least six areas where the government can and should do a better job of working with U.S. industry. Although we hear much talk about how poor we are, how we can't afford to provide school lunches, etc., the truth is we are still the the wealthiest nation in the world. We have an economy of over $6 trillion. However, we need a long term strategy to take more of that wealth and invest it for the future. We need to invest it in the same spirit that our nation did more than a century ago, in 1862 when Congress passed the Morrill Act which resulted in the development of a national network of land grant colleges and universities, and ultimately to our emergence as the most advanced agricultural and engineering nation in the world.

An investment strategy is illustrated in the figure 5 below. It needs to include public investments in each of the following areas as well as a strategy for encouraging private investments through tax provisions and favorable regulatory policies:

-Critical Technologies
-Manufacturing
-Physical Infrastructure
-Education
-Worker training
-Export Promotion

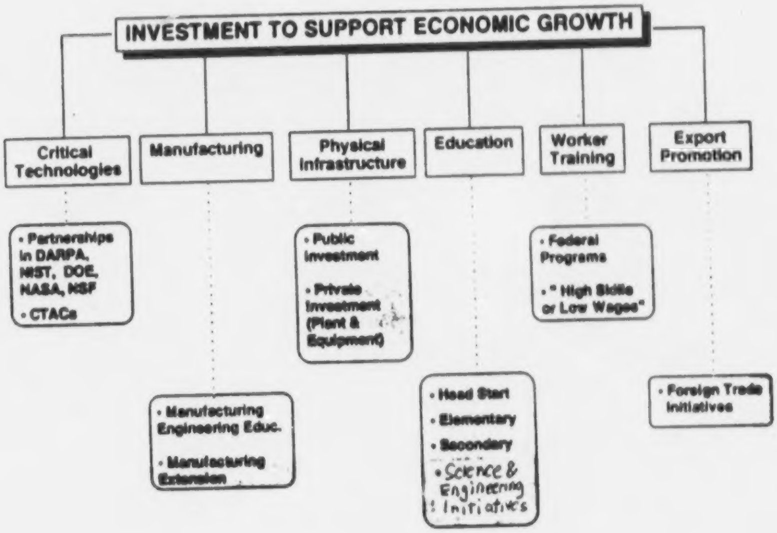

INVESTMENT TO SUPPORT ECONOMIC GROWTH
Critical Technologies
Manufacturing
Physical Infrastructure
Education
Worker Training
Export Promotion
• Partnerships in DARPA, NIST, DOE, NASA, NSF
• CTACs
• Public Investment
• Private Investment (Plant & Equipment)
• Federal Programs
• " High Skills or Low Wages"
• Manufacturing Engineering Educ.
• Manufacturing Extension
• Head Start
• Elementary
• Secondary
• Science & Engineering Initiatives
• Foreign Trade Initiatives

Figure 5

BEST COPY AVAILABLE

We need to fundamentally re-think the policies that we are pursuing as a nation in each of the above areas. What was adequate in education, or worker training in earlier decades is no longer adequate today. In each of these areas we can and must learn from our competitors.

Critical Technologies

The remainder of this paper is concerned with the first of the areas illustrated in figure 5.- Critical Technologies.

During the past two years, several critical technologies lists have been published. Numerous government agencies, in response to congressional mandates, and several private sector organizations have issued reports which list technologies considered critical to the U.S. In general, the published critical technologies lists identify "dual-use" technologies intended to serve both military and civilian requirements.

The most widely heralded list is The Report of the National Critical Technologies Panel, convened by the Office of Science and Technology Policy (OSTP). The preparation and distribution of this report is mandated pursuant to Public Law 101-189, November 29, 1989' (Title 42 U.S. Code 6683). This law requires biennial reports to be submitted to the President and Congress through the year 2000 by a National Critical Technologies Panel, established by the Director of OSTP (who is also the President's Science Advisor). Its first report, Reference [6], issued on April 25, 1991 focused on dual-use and product technologies essential to the "long-term national security and economic prosperity of the United States." Similar lists have been developed by the Department of Defense, the Department of Commerce, the Aerospace Industries Association, and the private sector Council on Competitiveness.

Panel Participants

Each Panel is to be composed of 13 individuals with expertise in the fields of science and engineering, chosen from the Federal government and the private sector. The composition is required to include representatives from:

U.S. government officials (3)[1]
Private Industry and Higher Education (total of 6)[1]
Department of Defense (1)[2]
Department of Energy (1)[2]
Department of Commerce (1)[2]
National Aeronautics and Space Administration (1)[2]

1-selected by the Director of OSTP/Chairman of Panel is selected from one of the Federal officials
2-selected by their respective agency heads

It is disappointing and disturbing to note that the Department of Education is not included as an agency representative.

Selection Methodology

The Panel established criteria for selection that were intended to highlight the importance of individual technologies to national security, the national economy, and to meeting other national requirements. The criteria may be placed within three broad categories and their elements that include the following:

(1) National Needs
    -Industrial Competitiveness
    -National Defense
    -Energy Security
    -Quality of Life
(2) Importance/Criticality
    -Opportunity to Lead Market
    -Performance/Quality/Productivity Improvement
    -Leverage

(3) Market Size/Diversity
- Vulnerability
- Enabling/Pervasive
- Size of Ultimate Market

The criteria were employed as a general framework within which to assess the "criticality" of candidate technologies. Primary consideration was given to technologies that could be incorporated into commercial products/processes or defense systems within 10 to 15 years.

The Selected Technologies

The National Critical Technologies Panel selected a set of 22 technologies which fall into the following six broad areas and their individual elements:

- **Materials** with properties that promise significant improvements in the performance of items produced and used by virtually every sector of the economy
    - Materials Synthesis and Processing
    - Electronic and Photonic Materials
    - Ceramics
    - Composites
    - High-Performance Metals and Alloys

- **Manufacturing** processes and technologies that can provide the basis for industry to bring a stream of innovative, cost-competitive, high-quality products into the marketplace
    - Flexible Computer Integrated Manufacturing
    - Intelligent Processing Equipment
    - Micro- and nanofabrication
    - Systems management Technologies

- **Information and Communications** technologies which continue to evolve at a breath-taking pace, permanently changing our approaches to communication, education, and manufacturing
    - Software
    - Microelectronics and Optoelectronics

  - High-Performance Computing and Networking
  - High-Definition Imaging and Displays
  - Sensors and Signal Processing
  - Data Storage and Peripherals
  - Computer Simulation and Modeling

- **Biotechnology and Life Sciences** advances that will permit unconventional approaches in such diverse fields as medicine, agriculture, manufacturing, and the environment
  - Applied Molecular Biology
  - Medical Technology

- **Aeronautics and Surface Transportation** systems that enhance our civilian and military capabilities and increase the ease and safety of travel
  - Aeronautics
  - Surface Transportation Technologies

- **Energy and the Environment** related technologies which have the potential to provide safe, secure and enduring sources of energy and ensure that a healthy environment is preserved for the use of future generations
  - Energy technologies
  - Pollution Minimization, Remediation, and Waste Management

Significance of Critical Technologies Lists

A major conclusion of the National Critical Technologies Panel report is that "...technology alone cannot ensure economic prosperity and national security. Technology can make an important contribution to the future of U.S. national interests, but only if we learn to utilize it more effectively."

The links from these critical technologies to the introduction and diffusion of technological literacy in our secondary school systems must be established. There is a danger in generating and promulgating lists of technologies as isolated elements. The danger is the technologies on these lists may suffer from the "fatal disconnection of subjects," analogous to that associated with non-integrated subjects in an educational curriculum. The lists from the National Critical Technologies Panel should be viewed as a set of tools we need to possess in our intellectual tool-box. These tools are most effective when they are used in concert with each other towards objectives which include improving our economic competitiveness and the technological literacy of our work-force.

The technologies identified by the Panel should be used as a guide for educators and educational associations much like the International Technology Education Association. The specific technologies can be used to assist in curriculum development in the primary and secondary schools, for teacher education, and for engineering student programs. Furthermore, the state-of-the-art boundaries of these technologies should be pushed by our engineers and scientists. Finally, our policy-makers should use these lists to establish and support technology development programs in the form of partnerships between the government and the private sector.

The identification of critical technologies and improving our technological literacy in our educational and training programs are just the first of many steps needed to revive our manufacturing sector and maintain it at world-class status.

CONCLUSION

Today historians write about the 19th century as the Golden Age of Industrial Strength in Victorian England. Fifty years from now, none of us would want to have historians writing about the 20th century as the Golden Age of American Engineering and Economic Strength.

If we wake up to the challenges, we can avoid this result. It will take leadership in industry, our educators, and among our policy-makers in government. These leaders must be able to break the chains of apathy, inertia, and ideology with which we needlessly bind ourselves. If the 21st century is to be an American century, as the 20th century has been, we need these leaders to come forward to meet the challenges.

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Applied Industrial Technology- A Junior High Technology Program

by

Jim Fellenberg

Prior to 1989 the students of Clark Junior High typically ended their elective industrial arts class with a drafting project, a sheet metal pan and a wooden bookshelf. The drafting exercise was a finely detailed orthographic view of a block of wood with a dado joint cutting the length of the top surface. Many of the finished projects were strikingly professional in appearance, only three weeks were required to develop the necessary skills to draw the three views. Some students were challenged just to make a straight line.

The bookshelf of aromatic cedar ranged from near craftsmanship to pieces never destined to be assembled into anything capable of holding even one book. A similar result could be witnessed with the three week metals project. Some projects were exactly formed and spot welded to precision while many were only weak attempts at making a pan.

1989 was the beginning of a significant change process. The focus of the vocational education program which explored two forms of materials and a few processes associated with each, plus the added challenges of perspective interpretation for drafting came to an abrupt halt. A new era of education began to form.

During the second semester of the 1988-89 school year students recognized a major swing to multiple activities where materials were not the division for emphasis. Materials of many types now became the topic of discussion as problem solving activities were presented to the students under one of four clusters. Commonly referred to as the technology clusters; construction, transportation/ power/energy, manufacturing, and communication were now addressed.

A New Look

Students who returned the following 1989-90 school year discovered immediately that change was welcoming them back. Where are all of the drafting tables? Why don't we use the metals room anymore? What happened to some of those big machines in that room (woods)? What are we going to do? (See attached floor plan.)

Were these questions of fear, interest or just an awareness?

Where once four rows of drafting tables formed 28 individual work stations, individual classroom desks now stood with enough extra space for a series of tables to hold five Macintosh computers and two dot matrix printers. Where three wood lathes had once collected a grey dust, new testing systems were displayed. One corner of the old woods lab had two tables supporting two robotic systems, one manually controlled while the other required a series of input commands to a CPU to control a robots every move. The robotic arm now controlled repeatable movements with accuracy not possible by human hands.

The next year saw even more changes. What was once a storage room had a new look. It was now strikingly finished, a communications lab, complete with carpet on the floor and accent stripes on the walls. Strategically displayed about the room were lasers, computers, and the robots which had been moved in from the newly commissioned fabrication

▦ CARPET

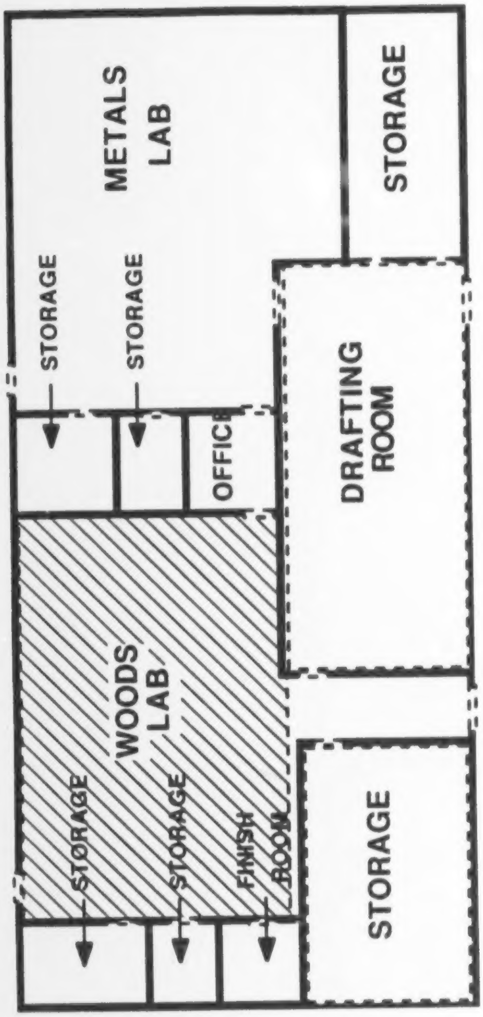
☐ CONCRETE

▨ WOOD

CLARK JUNIOR HIGH

TECHNOLOGY LAB

BEFORE


METALS LAB
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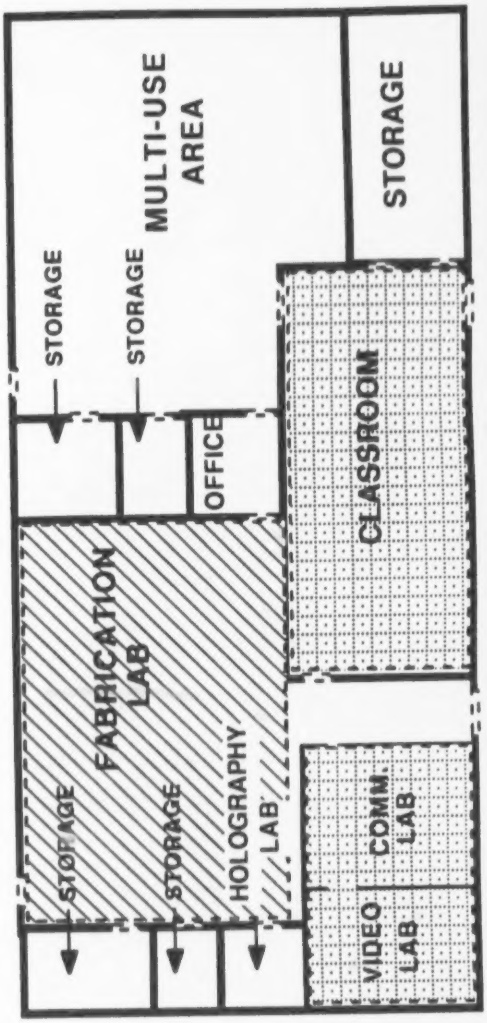
AFTER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HOLOGRAPHY LAB
COMM. LAB
VIDEO LAB

area. Part of the storage room had also been divided off to form a small video production room. The video room was equipped with a camcorder on a tripod, a simple editing system composed of two VCRs and a controller. A computer offered a fine selection of computer graphics and animation.

Classroom sets of hand tools were now either missing completely or had been reduced to numbers capable of meeting the needs of teams or individuals. Although a whole class may work on one particular problem there also existed opportunities for students to pursue activities of their choosing in a sequence of their desire.

The Blueprint for Literacy in Technology (BLT) Grant

Through a grant offered by the U.S. Department of Education, Clark Junior High became a pilot site for the implementation of a curriculum providing 29 activities (see attached list) over a nine week period or one quarter. The grant entitled Blueprint for Literacy in Technology was awarded through the joint effort of the University of Alaska and the Anchorage School District. Clark was just one of three junior highs identified to implement Applied Industrial Technology. It was a curriculum based on 29 activities complete with discussion topics, student problem solving activities, historical background, key terms and definitions, procedural steps, and a worksheet/self evaluation. The student found this broad range of activities a real test of their individual dynamics.

Students now had opportunities to select areas of technology which interested them. They were challenged to be creative by inventing ways to resolve problems. The need to organize time and a project sequence

BLUEPRINT FOR LITERACY IN TECHNOLOGY

JUNIOR HIGH/MIDDLE SCHOOL TECHNOLOGY PROGRAM

APPLIED INDUSTRIAL TECHNOLOGY

ACTIVITIES/LESSONS:

1. What is Technology?
2. Systems of Technology
3. Impacts of Technology
4. Robotics
5. Robot Programming
6. Laser Exploration
7. Laser/Fiber Optic Communications
8. Audio Visual Technology
9. Lifestyles in our Technological Environment
10. Materials Testing
11. Mass Production
12. Hydraulics
13. Computer Aided Drafting
14. Computer Designed Business Card
15. Windpower
16. Mechanical Power
17. Flight Simulator
18. Monorail Design
19. Satellite Technology
20. Electronics
21. Platform Design
22. Space Construction
23. Truss Construction
24. Pneumatic Structures
25. Proper Work Attitudes
26. Values & Work Ethics
27. Airplane - Design, Construction, & Flight
28. Understanding the Problem Solving Process
29. Specific Skills Needed for Employment

was necessary in order to complete the selected activities during the nine week session.

A program which once offered a set format of three activities traditional in nature was out. In was a program with a wide spectrum of concepts, diverse equipment and an expectation for creativity that used the same facilities and tools of the traditional program in order to allow the students to touch the future with activities as futuristic as lasers, computer applications, robotics, and applications of pneumatics and electronics. One may look back after such a radical change and attempt to question if there are justifiable gains or if the result was actually a loss.

Gains vs. Losses

It was this teacher's impression that the most significant gain was the increased interest level of the students in general and especially the high degree of that interest over the entire nine week period. In the past traditional program, students were excited and eager in the first couple of days on a project but in many cases by the time the three weeks ended for a given project, the student suffered a bad case of burnout. The technology activities were typically two-three days in duration. This seemed ideal for the junior high student.

A secondary benefit of this maintained high interest was the reduced almost eliminated degree of vandalism. What was once a daily routine of discovering what tool or equipment or fixture had been damaged or broken turned out to be quite insignificant. Students were so involved that they didn't have time to find destructive things to do.

Maintenance budgets required less money but they were more difficult to keep track of with the greater number of activities. In addition, another downfall to this new technology program was the amount of time needed to learn, organize and maintain the whole program so that the students could be assured that they had access to everything as identified in their activity packets. However, once areas could be isolated to specific activities and all the necessary support materials and equipment were in place the program became self directed. The teacher's time however, remained busy as the observation of many activities happening simultaneously is demanding.

Another advantage of the technology program is the ease of encouraging team work. Most of the activities lend themselves well to a cooperative spirit including brainstorming in design work and troubleshooting as well as in the construction and assembly processes.

Once a student or team of students have mastered an activity they then take on the distinction of being the resident consultant or expert in that field. Not everyone who completes an activity becomes a master. They must have scored 100% on their worksheet after demonstrating a high degree of skill and knowledge while working in a particular area. It is not unreasonable to end up with many consultants/experts that may share their knowledge with others in class, freeing up the teacher for other program needs.

If one was to identify the greatest drawbacks to the technology program the list would be short. In addition to the couple of points made earlier, another would be the time required to convert to a new organizational system and the need for new or reorganized space. This program seems to work best if a classroom can be provided adjacent to or incorporated in the activity areas of the technology lab. And finally, the student does not necessarily leave at the end of the quarter with a project to take home to use and display for years to come. However, it is worth pointing out that the number of projects left behind not completed were far fewer in the technology program than in the traditional program.

GRADING

Students are graded on 1) a daily learning log, 2) worksheets, 3) project performance and 4) lab participation. The learning log was a nine-week form printed on cardstock material and kept in a three-ring binder. Each student had an assigned binder which was stored in the classroom. All class information such as guidelines, information sheets, and activity packets were stored in the binders. The log sheet was to be entered each day the student was in class and reflected what s/he accomplished and learned that day.

The worksheets for each activity were generally completed as students finished a project. They often were turned into the collection basket from a variety of activities daily. Each worksheet was used to emphasize important terms and concepts associated with an activity as well as requesting information associated with any testing which might have been accomplished. Students were also encouraged to reflect on alternative approaches to their solutions and perceived improvements to their own efforts.

The process used to evaluate projects did not focus on its appearance with the exception of drafting or design activities. Projects were partially scored on performance but when possible other factors such as time in air, mass, distance, conservation of materials, time expended on activity and team efforts were added into the equation. Even the number of efforts made with documented alterations by the student played a significant role in a student's project grade.

Participation scores were based on student's attendance, classroom cooperation, safety, teamwork and special needs. The major emphasis was on each student's contribution to being a team member closely followed by safety.

Program Vision

The junior high technology program offers the students an opportunity to explore the technological world involving communications, transportation, construction and manufacturing. They explore it through a hands-on activity based process. Students are not expected to become masters or even skilled on any of the topics but to gain a "real" perception. They actually apply scientific concepts, mathematical processes and they get to develop and test their own ideas enabling them to broaden their problem solving abilities. Most importantly, the technology program is opening doors of interest for the students and planting a seed of challenge as they make their way toward the complex and rapidly changing world of tomorrow.

Jim Fellenberg has been a classroom teacher for eleven years. Ten of those years were at Clark Junior High where he initiated the move toward technology education as part of the exploratory program. In 1990 he was hired as a curriculum specialist for the BLT Grant project on a half-time basis. He is currently piloting two new technology programs at the senior high level at West Anchorage High.

Jim holds memberships in the Alaska Technology Education Association, the Alaska State Vocational Association, the American Vocational Association and the International Technology Education Association.

By

Mr. Don Bernard *

The **Blueprint for Literacy in Technology** project provided a model for secondary technology education facilities in the state of Alaska. This project also served as the framework and course description for a new delivery approach for traditional vocational education programs. The class concentrates on the integration of all subject areas with a hands on approach to self generated projects.

The units of study are:

1) Coping With Change - 5 days
2) Problem solving methods - 5 days
3) Impacts of technology - 10 days
4) Individual research in technology of greatest interest - 60 days
5) Project presentations - 10 days

The majority of the semester is spent on unit four with students working alone, or preferably, in small groups of up to four students on a topic of their own choice. Daily journals and learning logs have been incorporated into this course as a means to help guide and monitor students research.

This approach is very new to my students and they are sometimes at a loss when they find out they will not be tested every week or two on some facts I have given them. But rather, I expect them to come back and tell me what they have discovered about their topic.

As I begin unit one on change, I also begin to train my students on using writing to process their thoughts and ideas as well as to record factual observations. I have found high school students (grades 9-12) to be very reluctant writers and must be trained to use this important learning tool. As I teach the first three units I also begin to help my students practice the writing process.

The writing process forms a scaffold for my students to work from as they begin to research and author a final paper on their findings. This process consists of the following steps:

Prewrite
Write
Conference
Revise
Edit
Publish

When students are studying the unit on change, they are asked to write four fast write essays in response to different writing prompts. I use brain storming/webbing, a video-tape, a picture and a children's picture book as writing prompts. Following these prewriting activities, students are given 7 to 10 minutes to respond and reflect in writing. I have been amazed at the high quality of personal involvement and ownership of thinking that I see produced in these rough drafts. The children's story always seems to produce the highest number of quality responses and I am continually looking for new books to incorporate as thought provokers for these essays.

After students have had a chance to write four different first drafts, they are asked to select one to share with a small group of peers in a conference. These conferences are designed to provide for peer feedback and cooperative learning as students begin to develop their writing skills.

During a conference, each student reads their own work to the group. While doing so, students are usually able to punctuate the draft as they read aloud. The natural patterns of speech are heard, and students begin to transfer these patterns to their writing After each student reads, the listeners take turns providing feedback on what they liked about the work as well as possible suggestions for improvement or clarification of details in the writing. Students are hesitant to begin this activity and again, patience and persistence is the key to make this process work to the fullest.

Following the conference, students are asked to rewrite their first draft and prepare it for editing. Frequently, editing is interpreted as copying over in neater form and I must spend a few minutes explaining the expectations of a true re-vision of the original draft.

By the time a student has reached this revision, they have already processed their thinking on the chosen essay several times using various means of communication. In doing so, they have digested and personalized and connected to some important issues of discussion. The second draft is quite improved but usually requires at least one more editing conference before the work is ready to be published.

It must be noted here that every piece of writing does not go through this entire process but during the course of the semester students are able to pick and choose which drafts to complete.

When final editing is complete, students are encouraged to mount their essay and put it up for others to read. The pride of ownership in work displayed is amazingly motivational for students.

Unit two on Problem Solving is another great motivator and a fun hands on unit. Frequently, this is the first opportunity my students have had for this type of activity based education. By assigning short term problems with limited supplies and materials students are forced to stretch their imagination away from the traditional ideas. After the third problem we discuss the "process" of problem solving and how they approach this. We finally narrow the process to the four steps of Input-Process-Output-Feedback or the **I. P. O. F.** model. After this discussion students are given a couple additional problems to solve and are encouraged to use the I.P.O.F. design loop and try to consider any alternative solution to the given problem.

During the problem solving activities the student journal is integrated and used to record, sketch, ponder and reflect on the class activities.

The use of journals in class:

1. To summarize lessons
2. To record observations.
3. To record questions for further study.
4. To record progress in investigation.
5. Provides for documentation of work.
6. Provides accountability.
7. Reinforces responsibility.
8. Provides an avenue to express frustrations.

Attempts at paper towers and platforms, hot air balloons, balsa wood bridges, and junk gliders are always exciting and surprising. At the conclusion of the activity we debrief regarding the many different approaches used for the same problem. In addition, I try to emphasize the fact that no answer is correct or not, just one that happened to work this time.

During this unit, the use of the "Learning Log" is also incorporated with the following distinction made between the learning log and the daily journal.

The function of learning logs.

1. *Learning logs enable the children to express their feelings and opinions honestly to the teacher about the learning situations they have encountered.*
2. *Learning logs enable the child to carry on a conversation with himself about his learning.*
3. *Learning logs enable the child to engage in a private dialogue with the teacher about their learning.*
4. *Learning logs provide the teacher and child with a personal map of the progress they are making in their learning. They are a good way of finding out what has been learned and taken in.*
5. *Learning logs do not require a special writing style. The pupil/learner/writer is free to think/express himself on paper just as the words come. For this reason learning logs often carry a strong sense of the writer's voice, a personally conversational, infectious, colloquial, lucid, freedom of consciousness which more formal product oriented writing does not allow for.*

(Ben Brunwin, 1991)

Unit three on **Impacts of Technology** has been enlightening and interesting. At this point, students are exposed to the various technologies around them today and begin to develop an awareness of how their lives are impacted by them. Whenever possible, I invite the Director of Language Arts for Anchorage School District, Becky Sipe, to visit my class and introduce this unit with a story book prompt about the atomic bombing of Japan. Becky Sipe does a fascinating lesson on the positive and negative impacts of the technologies used to build, destroy and rebuild the city of Hiroshima. The responses are always interesting to read and many different opinions are found in every classroom.

As we explore the impact areas and issues, students begin to think about potential topics for individual research and discovery. Topics include robotics, laser applications, electronic communication, video production, genetic engineering, hydroponic gardening, alternative energy, magnetic levitation, or any other topic of interest to the student. Students are introduced to the idea of cluster areas with the following headings:

Construction
Communication
Transportation
Energy/Power
Medical Applications
Materials
Agriculture
Transportation
Environment

The students appreciate the opportunity to select their own topic for research and discovery. To provide for further ownership and personal involvement in Unit Four of individual research, I have implemented the I-Search format for the final paper of the research component of this class. When allowed to write in the first person, students feel more connected to their writing and find the writing experience more enjoyable and meaningful.

With the I-search format, the story of the search is as important as the findings. As we try to teach children to become life long learners and use various methods of information gathering, the process of searching is more important than the results of one search. A comparison of the I-search and formal research is listed below.

Classic Research Paper

- Introduction
- Methods
- Results
- Summary
- Appendices
- Footnotes (parenthetical quotes)
- Bibliography

I-search Paper

- What I chose and why
- How I searched
- What I found
- What I decided
- Junk
    - footnotes or quotes
    - bibliography
    - artifacts (pictures, sketches, etc.)
    - Sources
        - videos, films
        - interviews
        - fax or mail response

One very valuable source of information is the personal interview. As a means of helping students develop interviewing skills, each student is required to write a biographical sketch of another person in the class. Students choose interview subject by mutual birth month or some other random method. This usually provides an opportunity for students to get to know another person in class they have not met previously. This biographical sketch is included in the student's portfolio as an "about the author" narrative .

The final ten days of class is devoted to the sharing of individual or group projects. This sharing is done by oral presentation of research projects. Students are encouraged to invite friends, family, or other guests to see their presentations. In addition students have the option to deliver the presentation at a local elementary or junior high school. This option provides for increased promotion of this new curriculum as well as providing a means for my students to share their expertise with others. The response has been great from the elementary teachers and students. In addition, the high school presenters have the opportunity to be the real experts for this audience.

Student portfolios have been implemented as a means of evaluation and documentation of student progress and performance in this class. The following items are included in the student's portfolio:

1. Technology literacy pre-test.
2. First writing assignment, unedited first draft on what technology means.
3. Reading list of books and periodicals.
4. Short biography, "about the author".
5. Completed I-search papers.
6. Design plans and product sketches.
7. Photographs of project where appropriate.
8. Additional items selected by the student as being important to their learning in technology education.
9. First draft written last day of semester on what technology

means for comparison with number 2 above.

10. Technological literacy post test.

The Blueprint for Literacy in Technology has been a very exciting curriculum change for Chugiak High School and the Anchorage School District. The growth in student learning and enthusiasm has been stimulating and invigorating as I continue to work to improve upon the integration of all subject areas into Technology Education and prepare our students for their future.

With the explosion of technological innovations of today this exposure to the state-of-the-art equipment and their applications is vital for these students successful future. Of equal importance is the integration of the "academic" subject areas of math, science and social studies and language arts. A headline in Friday, June 5th, 1992 Anchorage Daily News reads: "Study: 10 million workers suffer literacy problems. Findings of a private research group show 'More than 10 million workers in small businesses have trouble doing their jobs because their reading, writing and math skills are so poor." By integrating the writing process into the technology curriculum, this project is beginning to make inroads toward addressing this problem and providing yet another "skill" for future employment.

* *Technology Instructor, Chugiak High School, Anchorage School District*

TECHNOLOGY EDUCATION: A REVIEW OF THE ANCHORAGE PROJECT

by

Kendall N. Starkweather, Ph.D.*

Overview

This conference and project have been about how we, as humans use technology to solve problems in our society. Each society and culture applies technology differently. James R. Johnson (1992), in a speech to the members of the American Ceramic Society noted that-

> "Technology is process, both technical process and social process. It is enhanced by the discoveries of science and shaped by the designs of engineering. . . It is designing things, making things, doing things, and it is introducing those things into society."

What we have observed from the Anchorage presentation is a program that is radically different from previous industrial arts programs which have existed in the United States during the past 40 decades. The emphasis has been placed upon the technology aspects of our society rather than the industrial or smokestack era. We have moved from an agrarian society to an industrial society on to an information society. At the same time, the field which was once known as industrial arts in an industrial era is being transformed into technology education during a technological era. The Anchorage Project has attempted to make the same progress through curriculum and activities. It started by utilizing two outstanding teachers and a series of activities designed to bring the learner closer to the evolving technological society.

Two notable strengths can be immediately identified with this effort: (1) A major strength of this project as with most educational situations has been the teachers, and (2) The relationship of the school system to the university has been a strong point that will help ensure the longevity of the effort. The personnel combined with the curriculum has produced a model program which is being replicated to many other situations.

Teacher Characteristics

This project has utilized teachers in such a way that they become the managers of education, involved in facilitating, stimulating, reinforcing, guiding and evaluating the student. Their task has been to draw the best out of people and to help them grow. Selected characteristics of such teachers are as follows:

- Has faith in youth's intelligence
- Sees education as a process-- not splintered excerises
- Emphasizes procedures, inquiry and discovery
- Sees role as stimulator, guide, evaluator and facilitator
- Has a positive approach to problems
- Stimulates student refinement of procedures
- Stays informed of technological developments
- Has broad perspective of possible student tasks
- Moves easily between dominant and supporting roles

More specifically, the teacher's role is to develop student skills and techniques, stimulate the students towards achievement, encourage student decision-making, become a resource for goal achievement, provide praise, encourage exploration and assist in student self-evaluation.

At the same time, the students are involved in interpreting the evolution and relationships created by technology. They establish beliefs and values as well as attitudes and abilities. They experience problem-solving situations and develop creative solutions. Most of all, they explore and develop their human potential.

These types of activities make technology education a vehicle for making decisions about technology. Students and teachers learn how to learn. Manipulative skills and problem-solving techniques are practiced. Sources of information are learned. Practice is given to learning how to put information and materials into construction activities. Finally, a total educational experience is provided through a dynamic situation with the student as the focal point of active learning.

Learning Environment

The teaching/learning environment of this project is strikingly different from those experienced by past industrial arts programs. Traditionally, the field has had a job analysis approach to teaching. Work focused on materials and things rather than on the human being. Such focuses included materials to be used, finishes applied, glues and tools used, all in a shop setting.

The changing nature of tools, materials, and equipment used in the instructional process represents technologies that are prevalent in our society. They present a whole different set of basics that will be learned by the student. For example, in former times the drafting student would practice making arrowheads for hours at a time. Today, with computer-aided-design (CAD), time can be spent learning other basic knowledge about the design process.

A modular approach has been the major instructional strategy implemented at the beginning levels of this project. As with any educational program, the instructional approach carries with it points that need to be considered as the program matures. For example, teachers in programs of this nature have traditionally had a difficult time moving beyond the initial instructional steps outlined when learning to teach using modules. Instead of teaching the same content in a similar manner year after year, new content and strategies should constantly be explored and modifications made to the program. Media resources should constantly be added to the process as they become available. If not, the program will soon become dated.

The approach taken in this project easily has the students involved with a heavy emphasis on the technical aspects of technology. The trend has been for technology teachers to spend less time addressing societal issues and values. This must not happen if a balanced view of technology is to be taught.

Technology teaching is about using technology in the solution of major problems that affect society. Educators who have traditionally dwelled upon the technical aspects of technology must broaden their view of this curricular area. They must involve their students in the impacts, issues, and values decisions that go with the positive and negative aspects in the use of technology. This does not necessarily mean less laboratory time, it does mean that a balanced view of technology should be taught. The technical emphasis can act as the vehicle for learning through the solutions being constructed during the study.

The use of the module teaching strategy creates various questions that must always be on the teachers mind. Those questions include-

1. What modules do I add or subtract from the units being taught?
2. What total technology picture or vision do the students get from their experiences in this class?
3. Did the students learn to follow directions or learn about technology?
4. How can the modules remain challenging to the students as they are upgraded or changed in the future?
5. What is the entrance level that a student must be able to obtain before going through such a program?
6. Are the experiences limited to what the teacher or directions prescribe?

Fortunately, this project includes methods that move beyond any one teaching approach such as the use of modules. Research has proven that various approaches to teaching and learning are to the benefit of both the teacher and student. The approaches which were implemented at the high school level utilized an open ended methodology which has much merit.

The Facilities

The terms "technology" and "techniques" deal with the concepts of "what is" and the "ability to do". Therefore, the laboratory environment of such a program is much different from the traditionally oriented industrial arts shop. With the content of the program dealing with technology, the nature of the project or activity is much different. The project becomes the vehicle for learning more about technology.

The facility for the classes at the high school level leaves more room for individual differences and learning about the total picture of technology. That strength also carries with it a weakness in that the teacher must have a different mindset than traditionally found in the industrial arts and vocational education areas. That is, the teacher does not dwell upon procedures as much as they dwell upon concepts and issues. Also, each student is learning on a parallel path but at different learning levels which produces a challenge to the teacher and the student. A challenge should be present in every learning situation.

The laboratory environment found in this Project is refreshing in that it presents a positive mental picture to the student or observer from the outset. All of the characteristics of a laboratory seem to have been taken into consideration to produce a facility that has flexibility in the use of tools, machines, and materials in a safety oriented setting for various types of teaching approaches. The key to keeping any facility updated is the ability to modify areas without disturbing the learning environment. That characteristic is evident in the work completed with this project.

Summary

The fast advancing, highly sophisticated technological society in which we live demands a holistic education about technology. Our educational system cannot continue to ignore the hands-on, minds-on experiences of technology education if it is to advance and be exemplary. Those who think that technology can be substantially addressed in the social studies and science disciplines do not truly understand the nature of technology. The industrial arts programs of the past served a very good purpose and had many educational characteristics considered outstanding. However, the time has come to carry those important characteristics forward in programs such as practiced in this Project and address the issues of present day and future technological societies.

* Executive Director, International Technology Education Association, Reston, Virginia
External Evaluator, Blueprint for Literacy in Technology Project

Tools For Overcoming Thought Barriers- The Missing Element For Developing Technology Education

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Tools for overcoming thought barriers – the missing element for developing technology education

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Dietrich Blandow

Abstracts

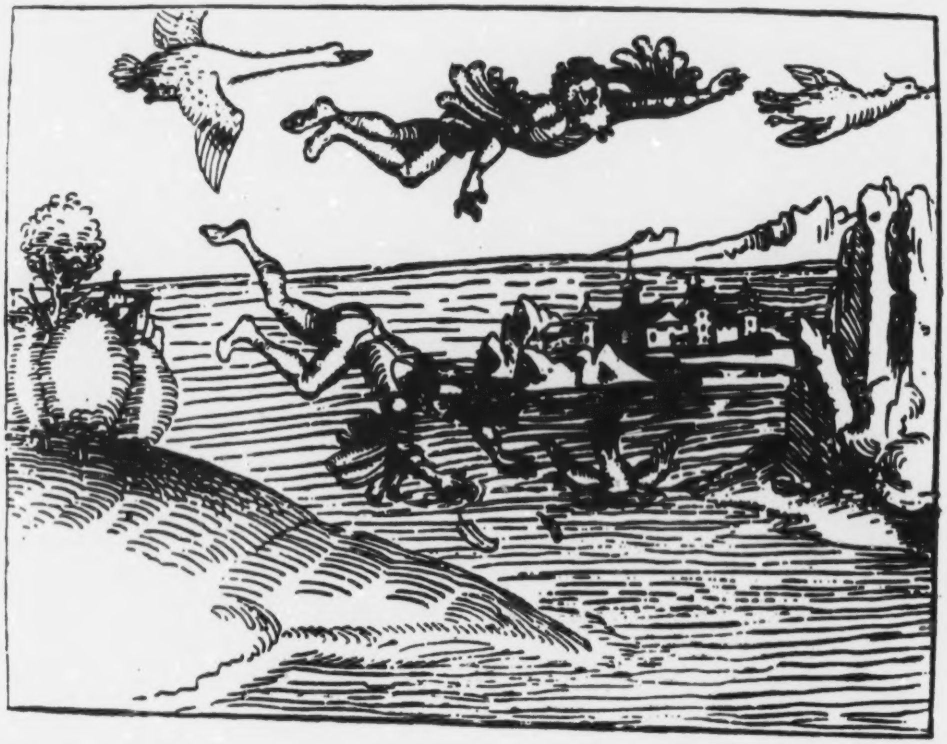
Theme:

Pedagogical tools to overcome thought barriers - the missing elements of effective technological education

All learning involves the overcoming of barriers. Therefore, the role of education is to frame situations that help people develop abilities to overcome barriers. In opposite to the classical engineering subjects and their structured contents the starting points for developing technological literacy will be seen in the typical human technological interface situations. Known situations are **Using, Evaluating, Producing, Serving, Recycling** and **Annihilation** of technology and technical artifacts. These typical situations combined with the subjects **Materials, Energy,** and **Information** but also with innovative **Ideas** leads us together with the invariants of the processes like **Forming, Altering, Transporting, Storing, Comparing / Separating, Comparing and Converting** to a variaty of situations. For setting up paedagogical situations typical barriers will be exemplifyd. In the summary the correlations between typical barriers, tools to overcome these and didactical pols will be offered as a new field for research in the field for developing technological literacy.

Tools for overcoming thought barriers - the missing element for developing technology education

All learning involves the overcoming of barriers and the role of education is to frame situations that help people develop abilities to overcome barriers. It will be acknowledged, that the human-technology interactions are the focus of development thinking. This is acknowledged around the world. But also known is the fable of Icarus.

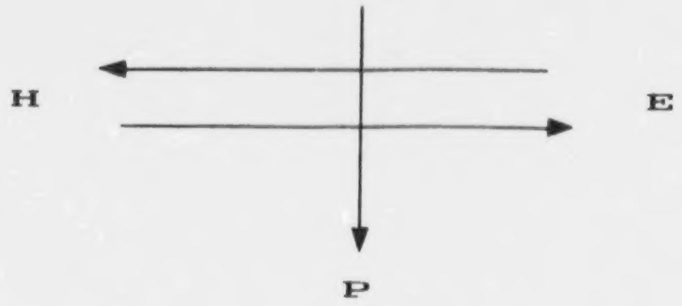


Daidalos und Ikaros nach einem deutschen Holzschnitt von 1497

Figure. 1

The example of Icarus points out an important concept. Not that we consider the school as an exile or prison. Instead, he has forced to learn to survive -- and to translate his wish for freedom into activities to keep busy. His vision of a palatable future, and with the example of the freedom of birds flying over him, triggered his modeling of their wings.

This example's lesson for today's situation is shown in Figure 2.



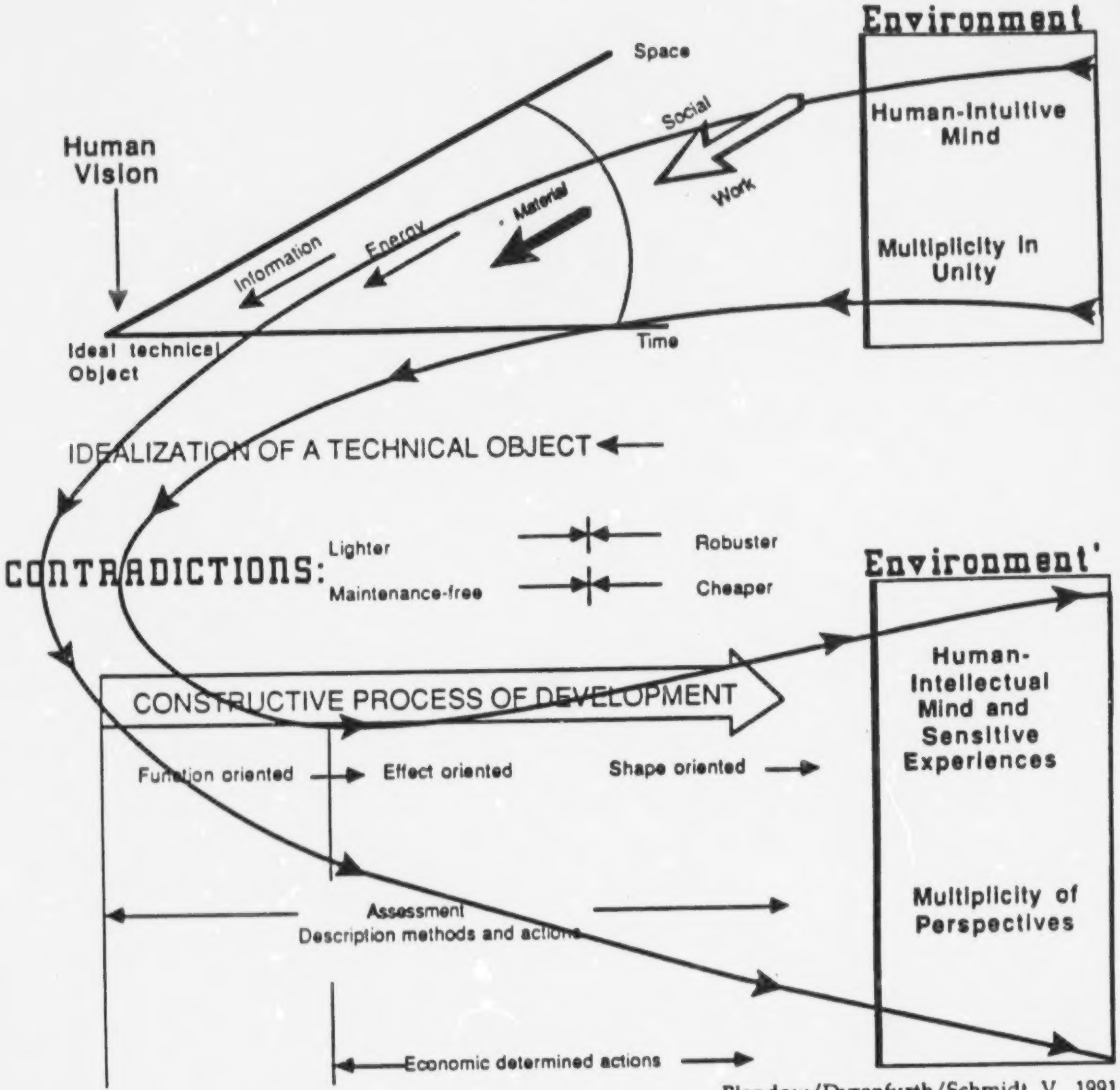
H: Human
E: Environment
P: Purpose

Figure 2. Basic relations for starting points

When we asked for an answer, then we need to be prepared to evaluate it also. He built wings and attempted to escape. The conclusion is known.

Problematic situation (thought initiator) → Overcoming thought barriers → imagining a vision of a possible solution → model development (resolution of contradictions) → development of approach strategies development of time and activity plan → execution of the plan → evaluation of the results → new situation/problematic situation

The cycle is important today. The example from the fable shows us today, as it did in the past, the relationship between the tangible world, our mental concepts of it, the initiating value of our concepts/visions, and the power of translating our ideas into practice via a systematic strategy. In further figures we depict the same concepts albeit with the addition of time and economics as a factor.


Environment
Space
Social
Work
Human-Intuitive Mind
Human Vision
Information
Energy
Material
Multiplicity in Unity
Ideal technical Object
Time
IDEALIZATION OF A TECHNICAL OBJECT
CONTRADICTIONS:
Lighter
Robuster
Maintenance-free
Cheaper
Environment'
CONSTRUCTIVE PROCESS OF DEVELOPMENT
Human-Intellectual Mind and Sensitive Experiences
Function oriented
Effect oriented
Shape oriented
Assessment
Description methods and actions
Multiplicity of Perspectives
Economic determined actions

Blandow/Dyrenfurth/Schmidt, V., 1991

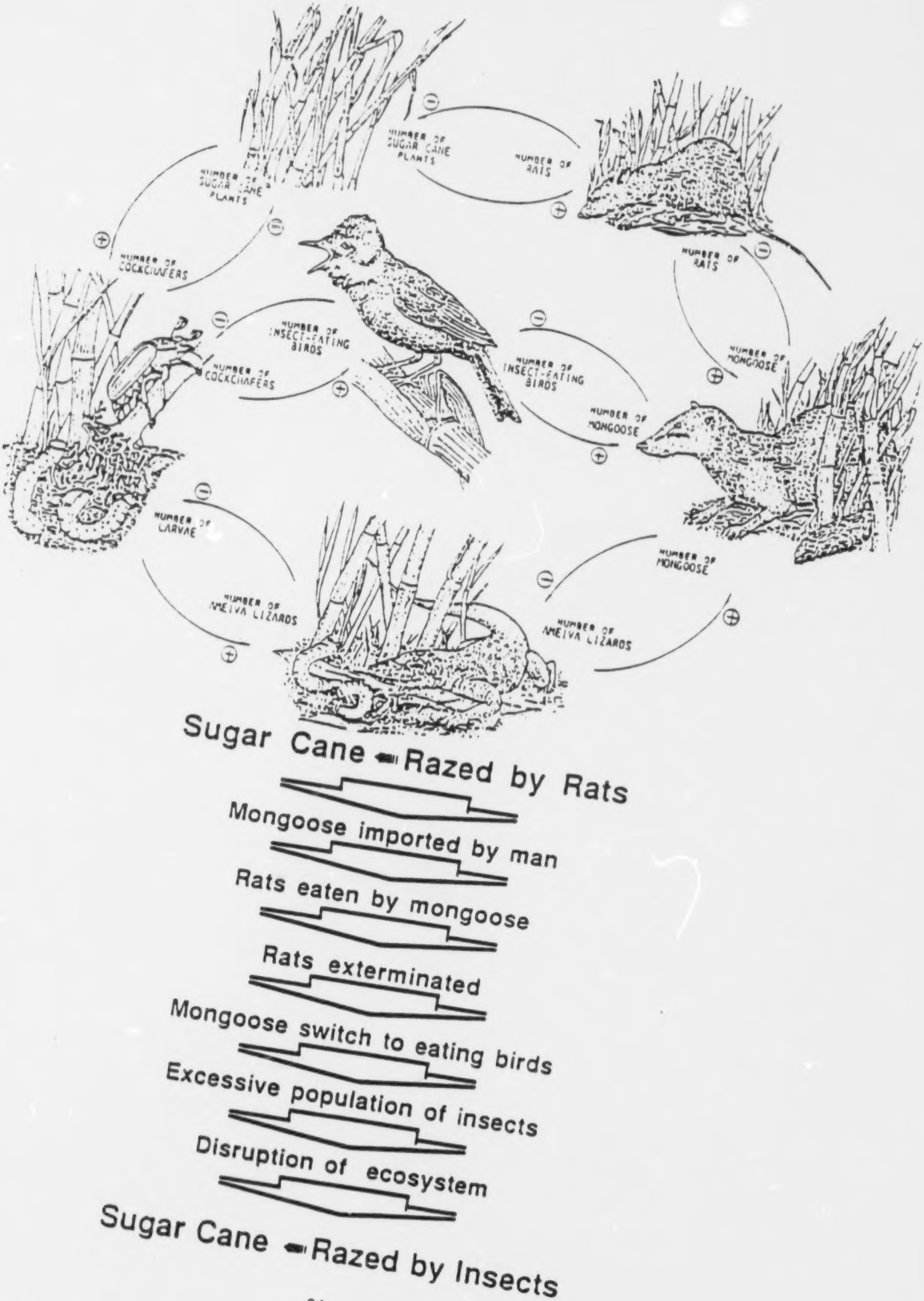
Figure 3 Concrete-abstract-concrete' – The routes of technical thinking

But this example also shows us which barriers we experience in our thought processes and how difficult it is to overcome them. The problematic situation was the starting point/initiator for all activities. Icarus had no concept relating the warmth of the sun to one's height (i.e., closeness to it). To properly judge a situation, technological or not, one must be cognizant of all aspects of it.

But we do not need to return to Icarus to recognize the lesson of this example. Consider the many calamities and problems we experience recently and today: The Tacoma Narrows Bridge collapsed in 1940; similarly, dam disasters, the garbage avalanche, chemical catastrophes (Bohpal), rocket explosions, Chernobyl, the high-rise living silos called apartments, hormone scandals in our food chain, and airplane crashes with a frequency that we have almost become accustomed to them. The world experiences a new Icarus daily! New, however, is that today the consequences of such failures affect all of, not just a single protagonist. Due to the pervasiveness and power of technology, the consequences are felt by all humanity. This new dimension, namely that all are impacted, engenders pedagogic consequences, that the resolution of problematic situations necessarily require the overcoming of thought barriers. To establish this power requires flexibility of approach and wideness of scope that cannot be accomplished solely in the school -- it necessarily requires the active involvement of the whole environment housing or learning institutions.

But the interesting part of Icarus is that he died - i.e., he failed. Therefore, he must have done something wrong. This pattern of error is repeated countless times.

Logical reasoning


NUMBER OF SUGAR CANE PLANTS
NUMBER OF RATS
NUMBER OF SUGAR CANE PLANTS
NUMBER OF COCKCHAFERS
NUMBER OF INSECT-EATING BIRDS
NUMBER OF COCKCHAFERS
NUMBER OF RATS
NUMBER OF MONGOOSE
NUMBER OF INSECT-EATING BIRDS
NUMBER OF MONGOOSE
NUMBER OF LARVAE
NUMBER OF AMEIVA LIZARDS
NUMBER OF MONGOOSE
NUMBER OF AMEIVA LIZARDS
⊖
⊕

Sugar Cane ← Razed by Rats

Mongoose imported by man

Rats eaten by mongoose

Rats exterminated

Mongoose switch to eating birds

Excessive population of insects

Disruption of ecosystem

Sugar Cane ← Razed by Insects

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All mistaken developments (e.g., DDT) and operational mistakes (e.g., Chernobyl) are rooted in thought mistakes. The latter are the lowest common denominator of all problems. This typically involves the insufficient consideration of the complexity of the systems and interrelationships involved, and their hierarchical structures. The conclusion is that the development of system-thinking, the consideration of hierarchical structures, and the tools for overcoming thought barriers represent an unsolved pedagogical problem.

> The creation of situations, through which learners overcome their thought barriers, and acquire an ability to interpret the world's complex systems, is the most urgent demand of our society's future!

What do we learn from these other than that we make mistakes daily?

We need to look more seriously because mistakes are more serious and affect more people today. The most frequent mistakes are that we do not think enough about the future impacts of current decisions/actions. Also, we think only about the system that houses the object of our decisions/actions. Too little attention is paid to the system's link to supra- and sub-systems.

Note, for example, that all systems operate within hierarchies and that effects are linked vertically as well as horizontally.

Figure 5. Systems hierarchy

Level Six	Cybernetic Systems	 Infrastructure
Level Five	Integrated Networked	 Traffic System
Level Four	Networked Systems	 Taxi System
Level Three	Systems	 Separate Automobiles
Level Two	Standard Assemblies	 Clutch
Level One	Standard Components	 Transistors

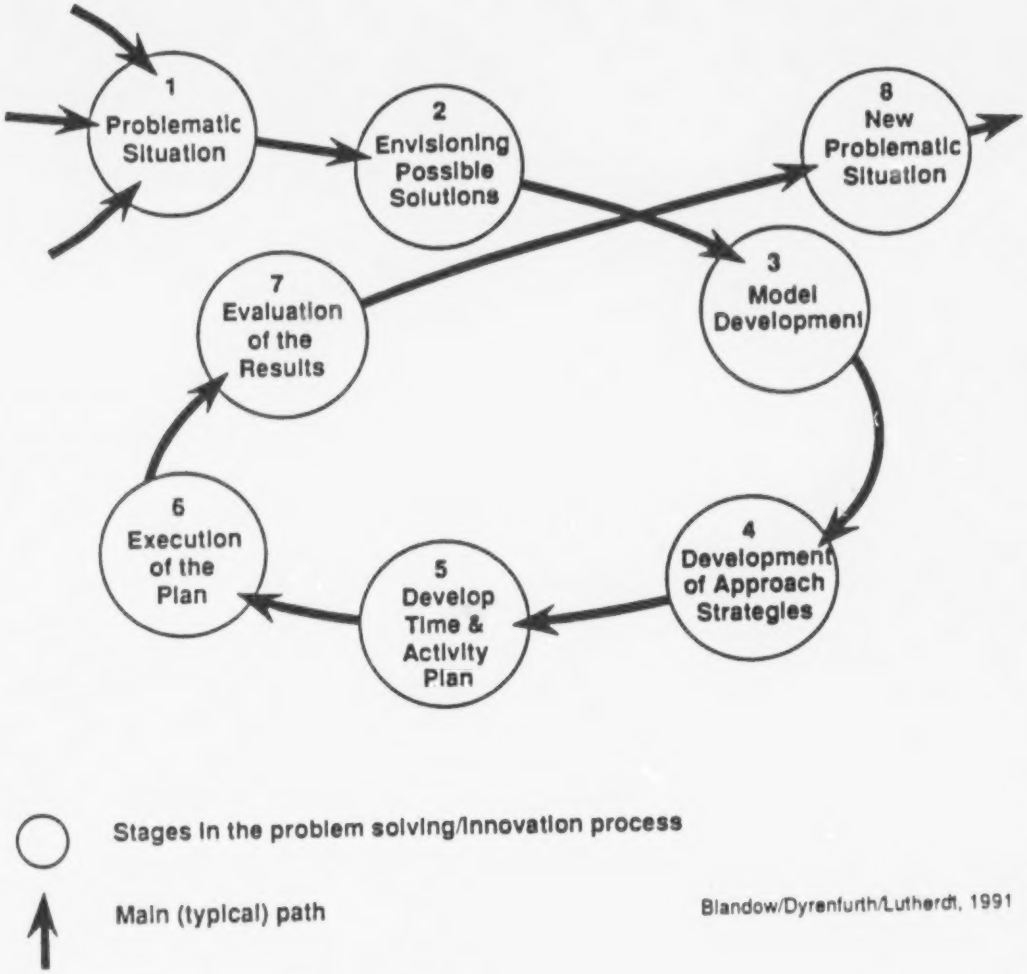
Figure 5. Systems hierarchy

Given our problems, it is clear that current education does not develop people sensitive to future impacts of technology, nor to its supra- and sub-system impacts.

To develop the needed systems thinking -- deciding about relationships and assessment of relationships -- is closely linked to the overcoming of barriers.

How can we help people to develop skills in overcoming barriers? Beginning right with the most basic concepts, consider the simple proposition that there are typical levels, objectives, between the starting- and the endpoint.

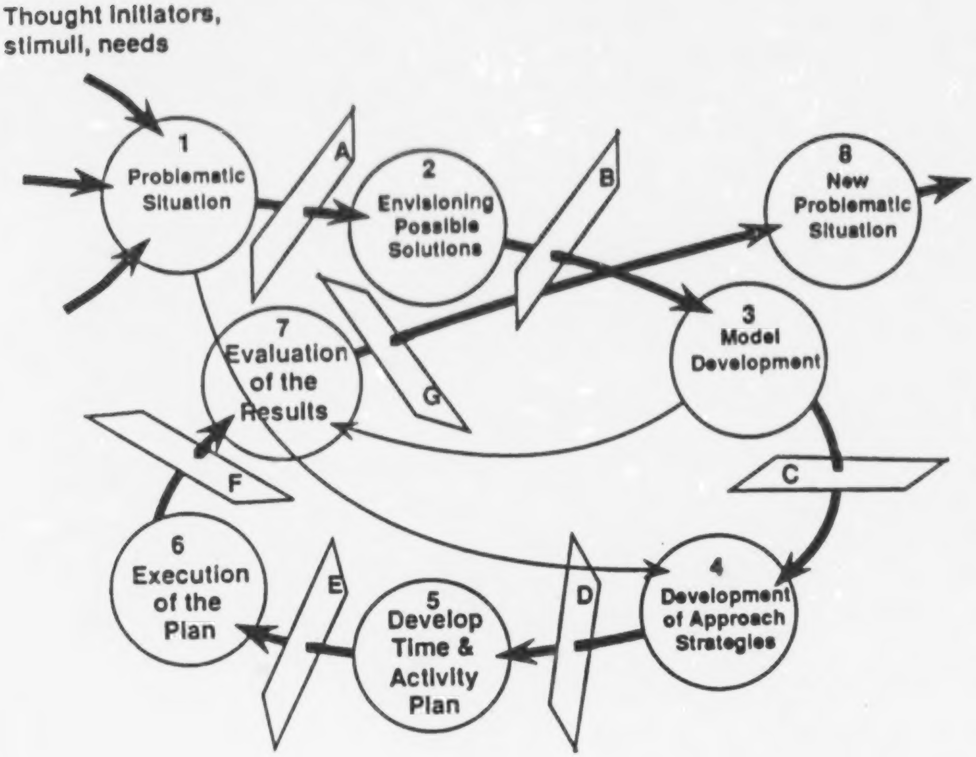
Now, look at this:


1
Problematic Situation
2
Envisioning Possible Solutions
3
Model Development
4
Development of Approach Strategies
5
Develop Time & Activity Plan
6
Execution of the Plan
7
Evaluation of the Results
8
New Problematic Situation
Stages in the problem solving/innovation process
Main (typical) path

Blandow/Dyrenfurth/Lutherdt, 1991

Figure 6 Stages in the problem solving/innovation process

The typical barriers between the stages are shown in figure 7.


Thought initiators, stimuli, needs
1 Problematic Situation
A
2 Envisioning Possible Solutions
B
8 New Problematic Situation
3 Model Development
7 Evaluation of the Results
G
C
F
6 Execution of the Plan
E
5 Develop Time & Activity Plan
D
4 Development of Approach Strategies

A. Recognition of trends, needs, ...
B. Definition of function, contradictions, ideal system
C. Solution of contradictions, variables, exploration of natural laws
D. Realizing of principles, development of material/energy/information system
E. Dimensioning of the elements/ manufacturing/testing
F. Modifying/optimizing the solution
G. Recognition of solution's weak points

○ Stages in the problem solving/innovation process

▱ Barriers to the problem solving/innovation process

⬆ Main (typical) path

↑ Alternative paths

Blandow/Dyrenfurth/Lutherdt, 1991

Figure 7. Stages of problem solving/innovation, barriers and paths

Note, the model actually identifies eight categories of barriers. These are:

1. Need aim barriers
2. Solution barriers
3. Ideal and contradiction barriers
4. Approach strategy barriers
5. Planning barriers
6. Executing barriers (theoretical as well as practical)
7. Evaluation barriers
8. Weakpoint barriers.

Given that people follow different paths through the barriers facing them and thus are linked themselves.

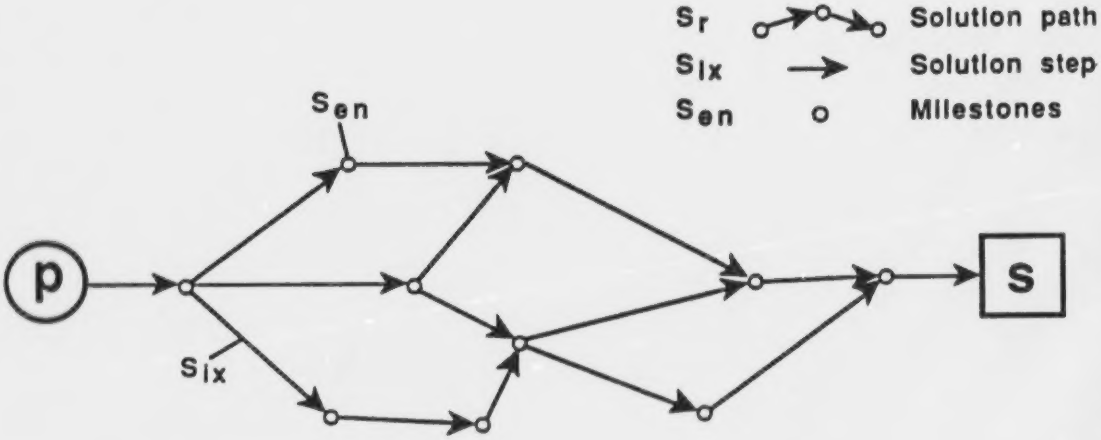


Figure 8 Problem - solution path alternatives

Furthermore, the entire process is set in a context (i.e., environment) that also colors / affects the process itself. This is depicted in the following illustrations.

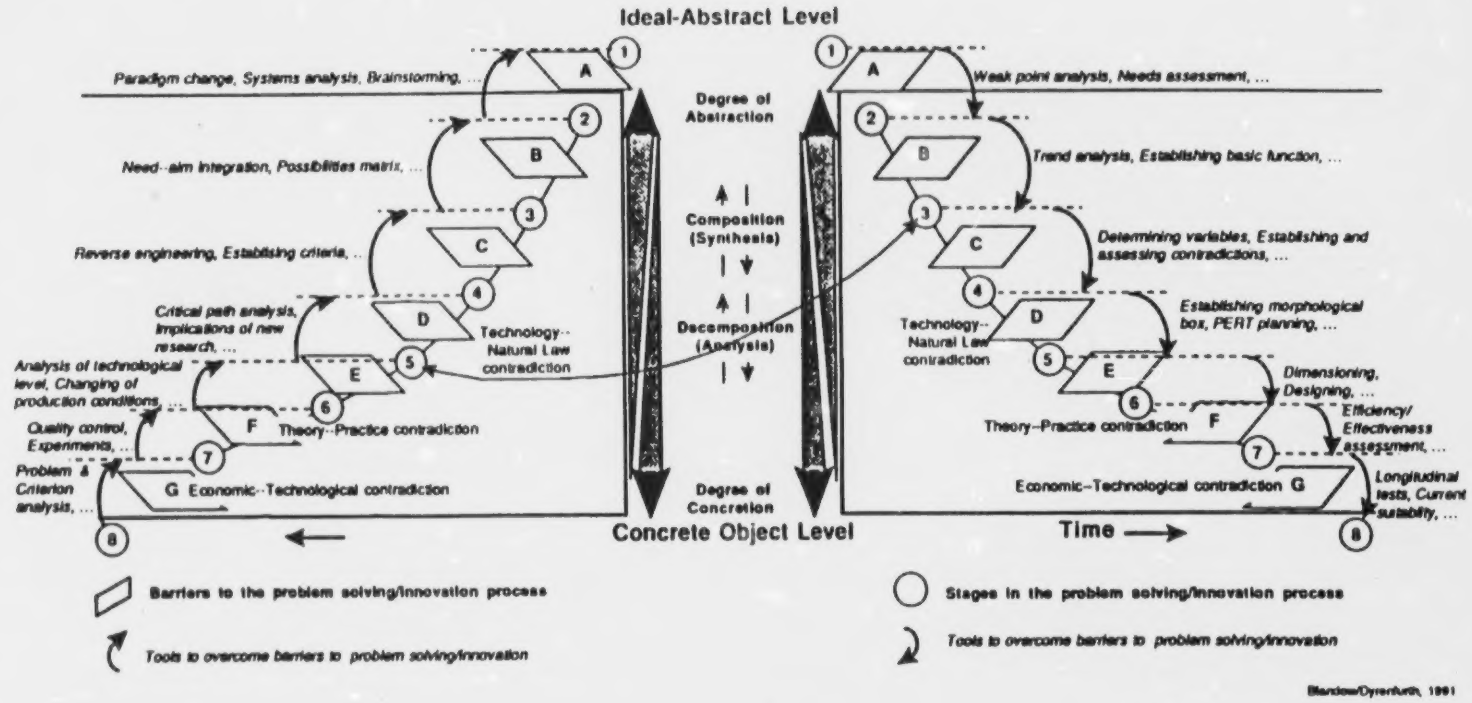

Ideal-Abstract Level
Paradigm change, Systems analysis, Brainstorming, ...
Need--aim integration, Possibilities matrix, ...
Reverse engineering, Establishing criteria, ...
Critical path analysis, Implications of new research, ...
Analysis of technological level, Changing of production conditions, ...
Quality control, Experiments, ...
Problem & Criterion analysis, ...
A
B
C
D
E
F
G
1
2
3
4
5
6
7
8
Technology--Natural Law contradiction
Theory--Practice contradiction
Economic--Technological contradiction
Degree of Abstraction
Composition (Synthesis)
Decomposition (Analysis)
Degree of Concretion
Concrete Object Level
Time
Weak point analysis, Needs assessment, ...
Trend analysis, Establishing basic function, ...
Determining variables, Establishing and assessing contradictions, ...
Establishing morphological box, PERT planning, ...
Dimensioning, Designing, ...
Efficiency/ Effectiveness assessment, ...
Longitudinal tests, Current suitability, ...
Barriers to the problem solving/innovation process
Tools to overcome barriers to problem solving/innovation
Stages in the problem solving/innovation process
Tools to overcome barriers to problem solving/innovation
Blandow/Dyrenfurth, 1991

Figure 9 Overview of problem solving/innovation stages, barriers and characteristic tools to enable establishment of solution strategies

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Returning to the example of Icarus, it becomes clear that between each of the various problem-solving steps, unsurmounted or inappropriately surmounted barriers exist. Ultimately this causes a failure of the flawed solution.

(see figure. 10 on page 15)

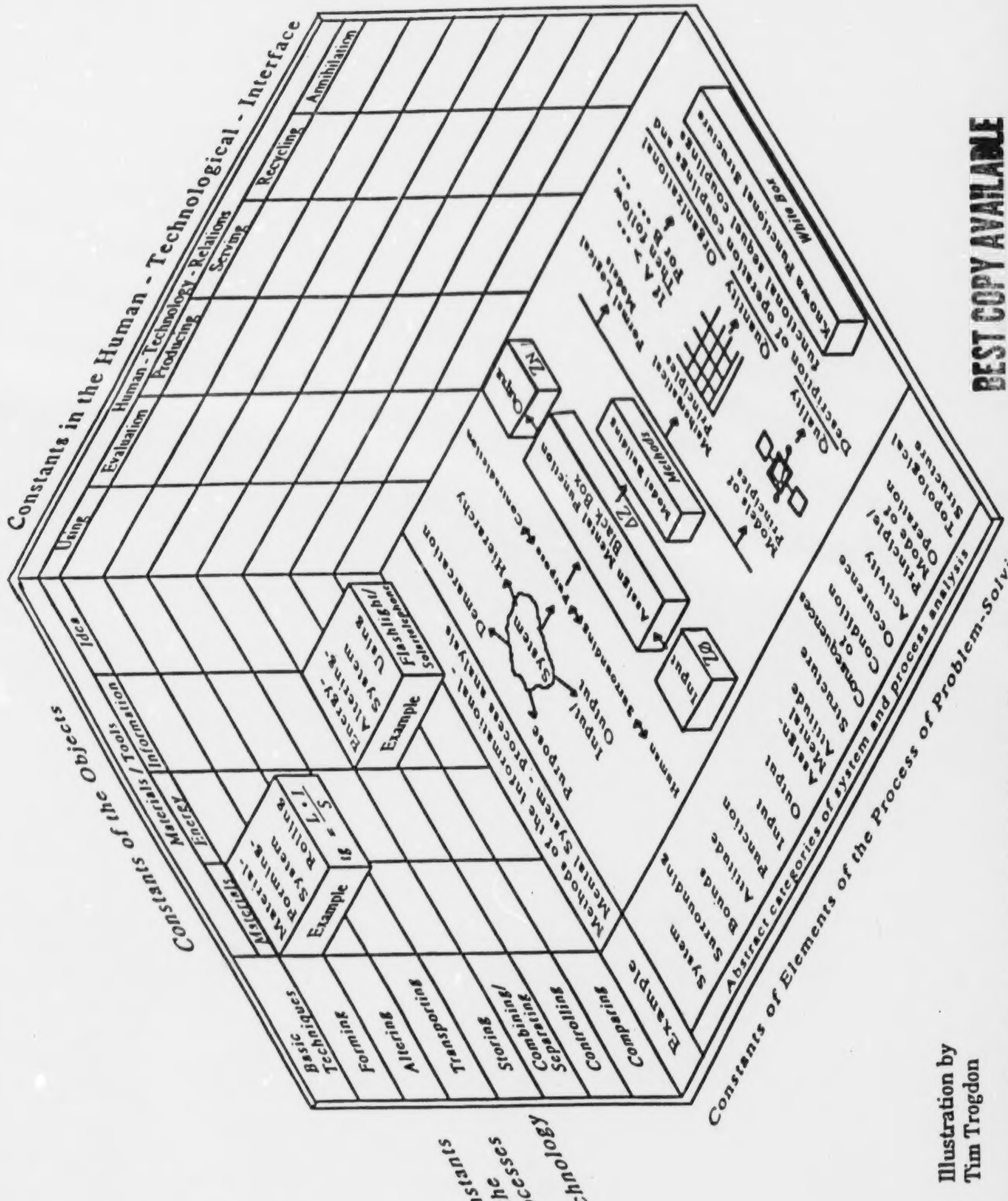
Constants in the Human - Technological - Interface
Human - Technology - Relations
Using
Evaluation
Producing
Serving
Recycling
Annihilation
Constants of the Objects
Materials / Tools
Materials
Energy
Information
Idea
Basic Techniques
Forming
Altering
Transporting
Storing
Combining/ Separating
Controlling
Comparing
Example
Constants in the processes of technology
Material-Forming-System Rolling
Example
Energy-Altering-System Using
Example
Flashlight/
Methods of the informational - Mental System - process analysis
Purpose
Input/ Output
System
Demarcation
Hierarchy
Human
Assign Mental Function Black Box
Input
Output
Model Building
Methods
Mathematical principles
Formal Logical Models
Models of principles
Quality
Quantity
Description of operation
White Box
System
Surrounding
Bounds
Attitude
Function
Input
Output
Structure
Sequence of Consequence
Condition
Occurrence
Activity
Principle/ Mode of Operation
Topological Structure
Abstract categories of system and process analysis
Constants of Elements of the Process of Problem-Solving

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Illustration by
Tim Trogdon

Figure 10 The modular concept of technology and work

In our view, we see that the proper overcoming of barriers requires an understanding of and capabilities with ideas, materials, tools, processes, and energy. In sort, this is the definition of technological literacy, which can be used in different areas.
(see Figure 11. Areas for interacting on page 17)

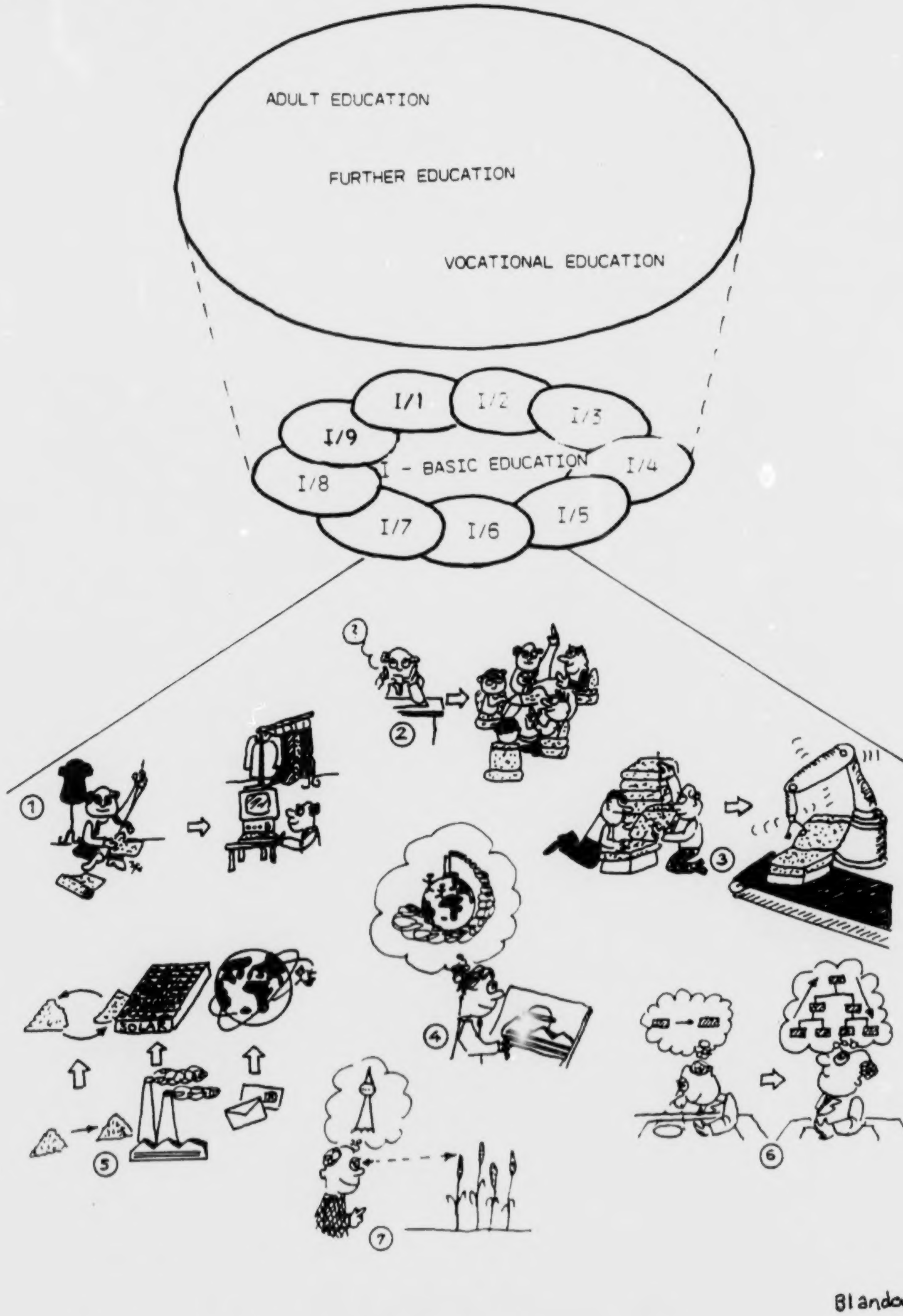
Hierarchical structure of components of education

I - basic education

I/1 - linguistic education
I/2 - mathematical education
I/3 - economic education
I/4 - scientific education
I/5 - aesthetic education
I/6 - technological education
I/7 - physical education
I/8 - political education
I/9 - artistic education

I/6/1- thinking in stages of development
I/6/2- thinking based on interactive ideas
I/6/3- thinking in terms of variables and decisions
I/6/4- thinking in terms of technological assessment
I/6/5- thinking in complexity
I/6/6- thinking in hierarchical and time oriented systems
I/6/7- thinking in analogies
(see also figure. 11)

FIGURE 11


ADULT EDUCATION
FURTHER EDUCATION
VOCATIONAL EDUCATION
I/1
I/2
I/3
I/4
I/5
I/6
I/7
I/8
I/9
I - BASIC EDUCATION
①
②
③
④
⑤
⑥
⑦
SOLAR

Blandow/Hill

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Technology is not a discipline that has only one task. Technology is a discipline that helps in the overcoming of barriers by producing the man-made world and using the living structure around us for (human) technological purposes. Key theoretical positions:

- The technology as a discipline to overcome barriers.
- The relationship between barriers and situations.

Now, what are the consequences of these two theoretical positions? What do we see when we canvas the situations wherein we learn?
(see figure. 12 on page 19)

Obviously, many things are already occuring. What is missing, however, is the development of systems thinking in schools. The interface of schools with industry offers rich potential for ameliorating this situation.

Actually, we could stop at this point.

- **The school's task is to educate**
- **To be able to learn, one must be able to overcome barriers**
- **The overcoming of barriers is linked to situations**
- **Because the environment is so complex today, schools cannot help students - learn to overcome the barriers they will encounter in the real world merely by using the abstracted simplified and safer environment created by and in schools.**

But according to our opinion, that the competence of orientation and action is being formed as a sectional quantity of social, natural, technological, and interest-/motiv-related subjective competence, it is necessary to investigate in future the correlations between the types of barriers and the fields of learning / didactical poles.
(see figure. 13 / 14 on pages 20 / 21)

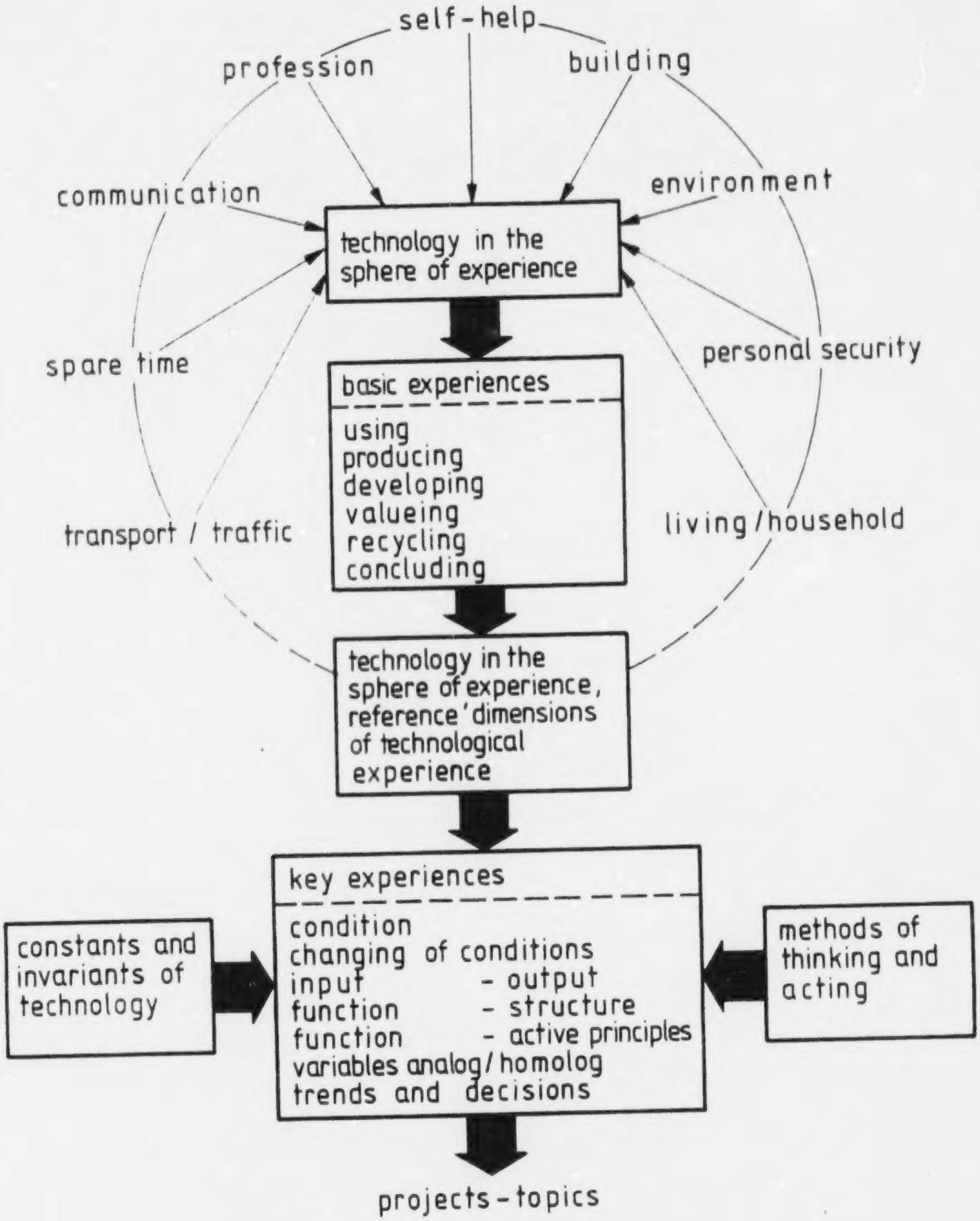

self-help
profession
building
communication
environment
technology in the sphere of experience
spare time
personal security
basic experiences
using
producing
developing
valueing
recycling
concluding
transport / traffic
living / household
technology in the sphere of experience, reference 'dimensions of technological experience
key experiences
condition
changing of conditions
input - output
function - structure
function - active principles
variables analog / homolog
trends and decisions
constants and invariants of technology
methods of thinking and acting
projects - topics

Figure 12. Basic structure of technological projects

POLES OF DIDACTICAL THINKING

SPECIFIC WORKPLACE KNOWLEDGE	PROCESS OVERVIEW
LOGICAL THINKING	ASSOCIATIVE/INTUITIVE THINKING
ORDERS, REGULATION	SELF DIRECTED/SELECTED TASKS
CRITICAL THINKING	UNCRITICAL ACCEPTANCE.
LEADING	FOLLOWING
ANSWERS FROM WRITTEN	LOOKS FOR THEORETICAL AREAS

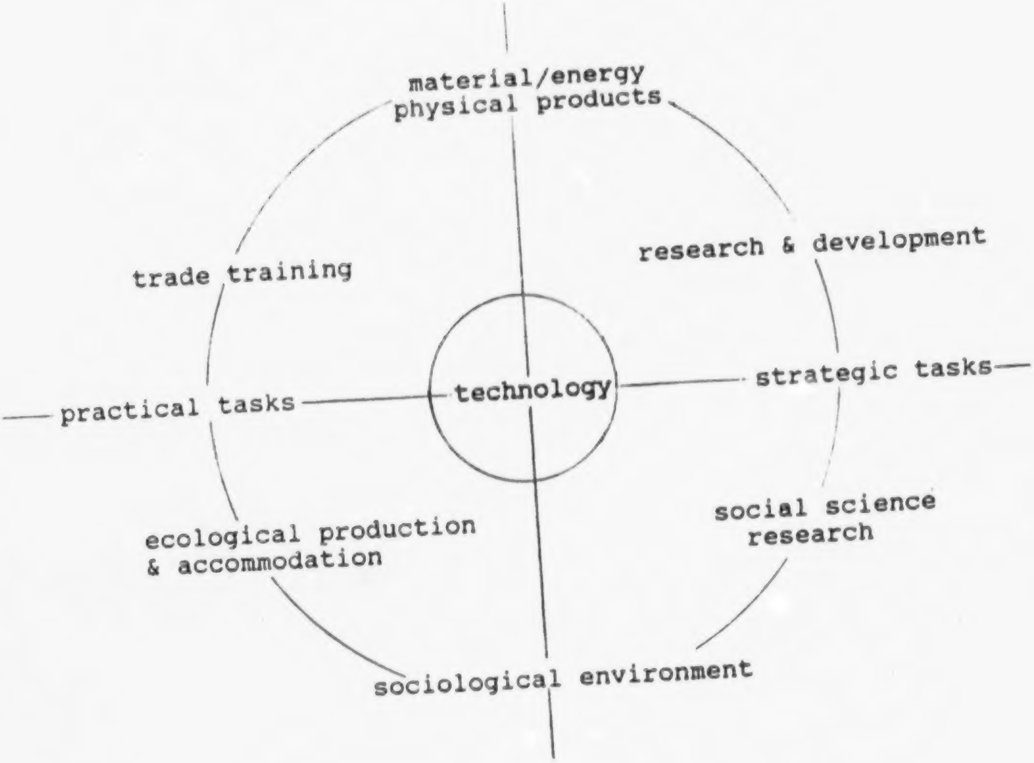
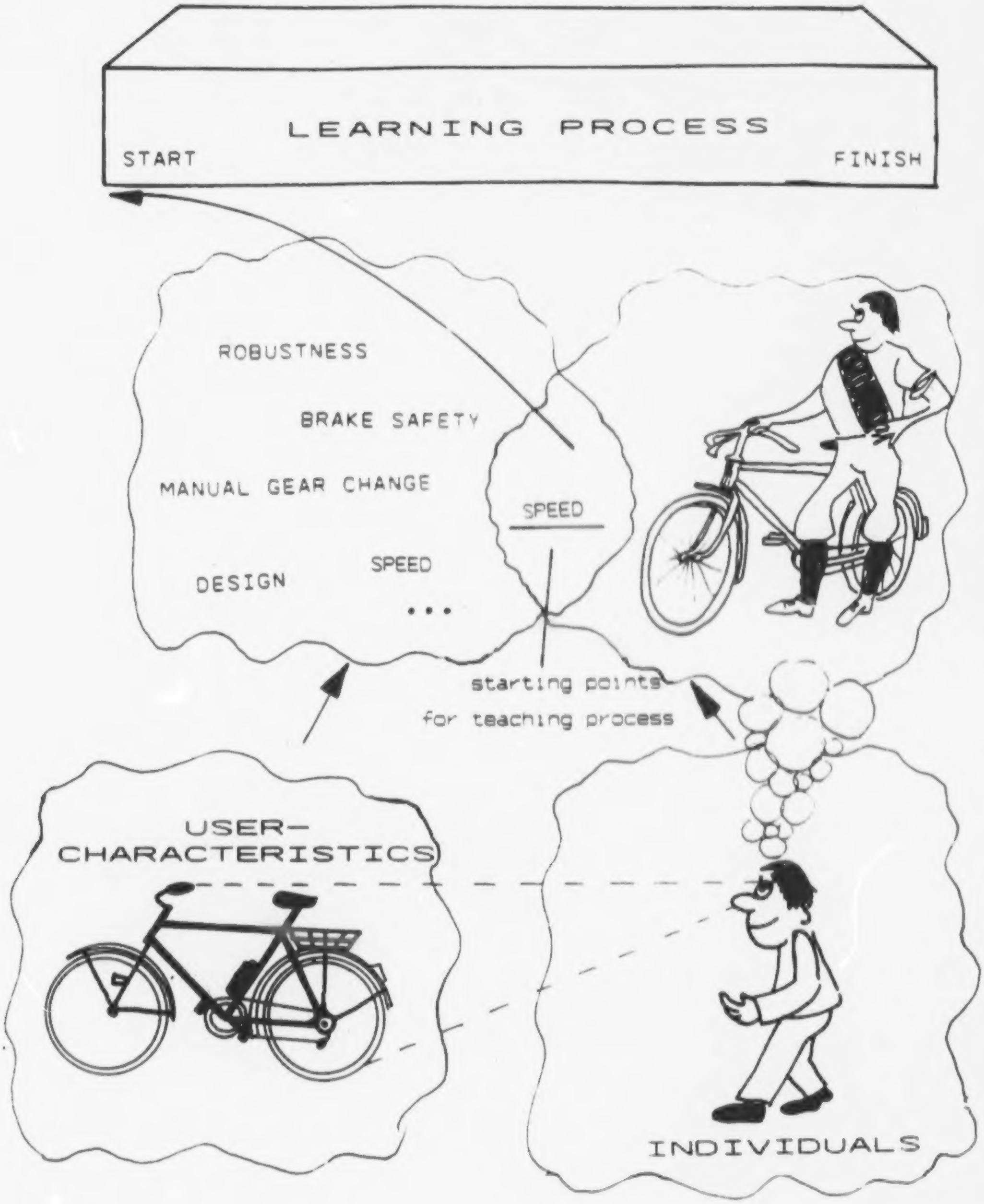

material/energy
physical products
research & development
trade training
strategic tasks
technology
practical tasks
social science
research
ecological production
& accommodation
sociological environment

Figure 14. Didactical orientation sections

Or with other words we have to answer the question which pedagogical efficiency is proved by special technological spheres. The starting point leads us to the user characteristics (see figure. 15).

FIGURE 15

HUMAN TECHNOLOGICAL INTERFACE


LEARNING PROCESS
START
FINISH
ROBUSTNESS
BRAKE SAFETY
MANUAL GEAR CHANGE
SPEED
DESIGN
SPEED
...
starting points
for teaching process
USER–
CHARACTERISTICS
INDIVIDUALS

Blandow/Hill

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April 27 - 30, 1990

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Wissenschaftliche Zeitschrift, Pädagogische Hochschule Erfurt, 1990

Technology Education in Japan

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Dr. Sam Stern, Visiting Professor
Department of Systems Science
Tokyo Institute of Technology
(On leave from Oregon State University)

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1. An Overview of the Japanese Educational System

In recent years, Japanese industrial and educational practices have received worldwide attention. In spite of the interest in Japanese industry and education, there has been relatively little study of technology education in Japan. This paper describes the history and current status of technology education in Japan. Because of their close relationship, discussion of both technology education at the lower secondary level, *gijutsu ka*, and vocational technical education at the upper secondary and post-secondary level, *shokugyō kyōiku*, are included in this paper.

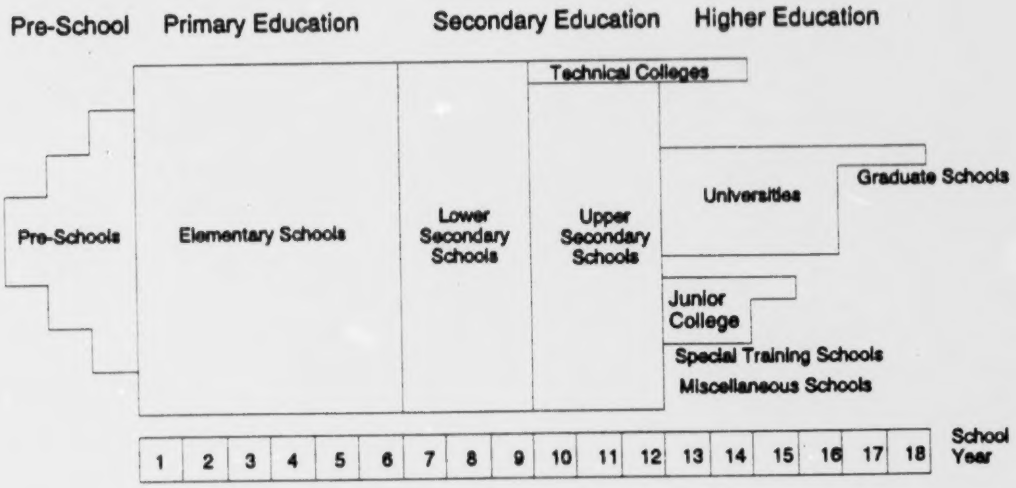
Pre-School
Primary Education
Secondary Education
Higher Education
Technical Colleges
Pre-Schools
Elementary Schools
Lower Secondary Schools
Upper Secondary Schools
Universities
Graduate Schools
Junior College
Special Training Schools
Miscellaneous Schools
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
School Year

Figure 1. Organization of Japanese School System

The structure of public education in Japan is largely based on the American model of education which was adopted after World War II. Figure 1 shows the major types of publicly supported schools. The foundation of the modern Japanese educational system is the nine-year compulsory education core, *gimu kyōiku*. Included in the compulsory core is a six-year elementary school, *shōgakkō*, and a three-year lower secondary school, *chūgakkō*. Practically all (almost 100%) of Japanese students complete compulsory education. After completing compulsory education, the vast majority of students enter upper secondary school. In the 1990-91 school year, 100 percent of eligible students were enrolled in elementary schools; 95% of lower secondary school graduates entered upper secondary schools; and 53.7% entered college, university or other type of post-secondary institution (Ministry of Education, Science, and Culture, 1991).

2. Curriculum in Transition

Unlike America, Japan has a strong national system of education. Curricula for elementary, lower secondary, and upper secondary education is promulgated by the Ministry of Education, *Mombusho*. The Ministry of Education issues a new Standard Course of Study for each educational level about every ten years. Suggestions for curricular revisions are made by various committees that include curriculum specialists, university professors, classroom teachers, members of local boards of education, and others.

Changes in Japanese technology education programs following World War II can be divided into four eras: 1) Economic Reconstruction Era, 2) High Economic Growth Era, 3) Stabilized Economic Era, and 4) International Era (Murata, 1990). Table 1 shows the socio-economic conditions that were characteristic of each era, and upper secondary and post-secondary enrollment percentages.

Table 1. Socio-Economic Development and Educational Enrollments

Era	Socio-Economic Conditions	Enrollment Percentage	
		Upper Secondary	College/ University
Economic Reconstruction Era	Shortage of housing and food.	43.0% (1950)	
		51.5% (1955)	10.1% (1955)
High Economic Growth Era	Promotion of science & technology.	57.7% (1960)	10.3% (1960)
		70.7% (1965)	17.1% (1965)
	Rapid economic growth (about 10%)	82.1% (1970)	24.0% (1970)
Stabilized Economic Era	Oil crisis (1971 & 74).	91.9% (1975)	34.2% (1975)
	Economic growth slows and stabilizes (3-5%).	94.0% (1980)	31.9% (1980)
International Era	Growth of microelectronics & service industry.	94.1% (1985)	30.5% (1985)
	Internationalization of economy.	94.7% (1989)	30.6% (1989)

2.1 Establishment of Vocational Technical Education as a Required Subject

After the end of World War II, the Japanese economy was seriously disoriented. Under the leadership of the U.S. Occupation Forces, various reforms in the economy and educational programs were initiated.

As shown in Table 1, during the Economic Reconstruction Era, about half of lower secondary school graduates began work immediately after graduating. At that time, vocational education was a required subject in lower secondary schools for all boys and girls, consisting of courses related to agriculture, industry, business, and home economics. The curriculum varied from school to school depending on the school's location. One of the main goals of vocational education was career education through experiential learning.

2.2 Introduction of Technology Education

Following the successful launching of the Soviet satellite "Sputnik," Japan, like many other countries around the world, tried to improve their science and technology education programs. One of the policies adopted by the Japanese government in late 1957 was the introduction of technology education, *gijutsu ka*, as a required subject in all lower secondary schools beginning in 1958.[1] With the introduction of technology education in the lower secondary schools, vocational education was moved to the upper secondary level as an elective course.

The major objectives of technology education in 1958 were: 1) to help students learn basic skills through creative/productive experience, to understand modern technology, and foster fundamental attitudes for practice; 2) through experience of design and realization, to foster skills for presentation, creation, and rational attitudes for problem solving; and 3) through experience in manufacturing/operation of machines/devices, to understand the relation between technology and life and to foster attitudes for improving technology and daily life. Major content areas included design and drawing; woodworking and metal working; machinery; electricity; and cultivation. A total of 105 hours in each of the three grades of lower secondary school was allocated for technology education.

In 1960, the Japanese government set out to double the number of technical high schools. During this era, five-year technical colleges for the graduates of lower secondary schools were established. To respond to the shortage of skilled technical teachers, three-year teachers' colleges for technical education were established. These colleges were attached to Faculties of Technology at Japanese national universities. During the 1960's these colleges enrolled about 900 students each year. These policies were all related to Japan's "Doubling the National Income Program." At the beginning of this era, the *Ministry of Education* sent a curriculum specialist in technical education to the U.S. to gather information about technical-related subjects (Suzuki and Murata, 1990).

---

[1] The same term, gijutsu ka, has been consistently used to describe industrial arts/technology education classes in Japanese lower secondary schools since its introduction in 1958. Gijutsu means technology and ka means subject.

2.3 Introduction of Fundamental Subjects and Equal Opportunity in Education

Throughout the High Economic Growth Era, the percentage of Japanese students enrolled in upper secondary schools and higher education institutions continued to increase. However, the knowledge and skills needed in the workplace changed dramatically. In industry-related sectors, employers wanted workers to have greater flexibility and trainability. During this era, Ministry of Education introduced fundamental subjects to vocational technical courses and also introduced work experience activities to general courses.

In this era, issues related to equal educational opportunity in secondary education began to emerge. Until then, all male students participated in technology education classes and all female students participated in home economics classes. To provide equal educational opportunity, beginning in 1977, the Ministry of Education required all male students to take at least one home economics class and all female students to take at least one technology education class.

In upper secondary schools, students enrolled in vocational technical education were required to take fundamental subjects such as "Fundamentals of Industry," "Mathematics in Technology," and "Practice." The goal of these subjects was to improve students' fundamental knowledge and skills, as well as accommodate new teaching materials and methods. At that time, work experience activities were introduced into general courses for all students. (Tamura, Arai, and Murata, 1985)

2.4 Introduction of "Fundamentals of Information" into Lower Secondary School and "Independent Study Project" into Upper Secondary School.

To respond to changes in the workplace and society, the Ministry of Education initiated several changes in the late 1980's. One of the major changes was the inclusion of a new computer literacy course in technology education programs in lower secondary schools. The primary objective of the new course is to help students understand the roles and functions of computers, and develop capability for the use of computers and information. Major content areas include computers and society, computer hardware, computer software, and application of computer software.

Although the new computer literacy course is not one of the four required courses (woodworking, electronics, home life, and food), it is one of the most popular elective courses. According to a study by the Ministry of Education (1991) 76% of all students want to take the new computer literacy course.

In the upper secondary school level, the Ministry of Education revised technical courses to encourage the development of basic skills and flexibility. In general subjects, the Ministry of Education encouraged the use of computers in science and mathematics. All vocational students are required to take a new information technology subject related to their major course, such as agricultural information processing and home economics information processing. One of the most significant revisions in upper secondary technical courses is the introduction of integrated problem solving courses, such as "mechatronics," applied mechatronics," and independent/assignment project study.

The primary objective of the new mechatronics course is to promote the understanding of fundamental knowledge and skills related to mechatronics (a combination of mechanics and electronics). Major content areas include basic machines and devices, sensors, A/D conversion, logic circuits, actuators, mechanics, and power transmission devices.

In general, there has been a movement toward a broader view of technology education and vocational education in Japan. However, a broader and less "subject-specific" approach can result in a relatively shallow educational experience. The primary objective of independent project study is for students to deepen and integrate knowledge and skills through problem solving and industrial projects. Major content areas include design, manufacture, research, experimentation, the study of workplace practice, and acquisition of professional/vocational certificates. Examples of projects include the design and manufacture of robots and remote control models (Murata, 1990).

3. Technology Education Teaching Methods

From the beginnings of technology education in Japan, the primary teaching methodology was experiential, based on the project method. Technology education classes in Japan are typically organized into lecture and practice classes. Practice classes (laboratory work) usually have less students than lecture classes[2]. More recently, new types of project activities have been introduced that attempt to integrate different technical areas and lecture content.

---

[2] Average class size in Japanese schools is larger than in America. The average class size in Japan is approximately 40 students per class.

4. Support for Technology Education

4.1 Facilities and Equipment Support

The Vocational Education Promotion Law was enacted in 1951. As a result the national government, through the Ministry of Education, was obligated to promote vocational technical education and encourage local governments to support facilities for vocational technical education. After the development of each Standard Curriculum, the Ministry of Education promulgated technology education and vocational technical education equipment standards. The national government provided subsidies to upper secondary schools that amount to approximately one third of the budget for vocational technical education facilities and equipment.

4.2 Initial and In-Service Teacher Training

Initial teacher training for technology education and vocational technical education primarily occurs in the Engineering Colleges or technical education departments of national universities. Because of rapid changes in technology it is often necessary for technology education and vocational technical education teachers to be retrained. After each major curriculum revision, the Ministry of Education planned and implemented in-service training programs. A good example is the major in-service effort to prepare the approximately 16,000 Japanese technology education teachers to teach the new course on computer literacy. In the first stage of the in-service program, about 160 technology teachers received two weeks of full-time in-service training. Over a three-year period, a total of 480 such "lead teachers" received similar training. In addition to the two weeks of intensive training, these teachers assume personal responsibility for self-study about computers. Each newly retrained teacher returned to their district and began training other technology teachers in their district. In-service training at the district level continued for four years (1988 through 1992) providing in-service training to all technology education teachers in Japan (Stern and Matsuda, 1988).

4.3 Educational Centers for Technology Education

Every one of the 47 prefectures in Japan has an education center that includes a department of technology/industry-related education (including information technology). Some of the large prefectures have independent Centers for information technology or technical education. These educational institutions serve several functions including teacher retraining, development of teaching materials, and research on educational methods. In order to use prefectural educational budgets effectively, educational centers are equipped with expensive facilities such as large scale computer systems and machining centers.

4.4 Textbook Examination and Subsidies for Compulsory School Textbooks

All textbooks used in compulsory schools and most upper secondary schools are compiled and published by private publishing companies, and subject to approval by the Ministry of Education. All compulsory school textbooks, including technology education textbooks, are provided to students at no cost.

5. Problems Facing Technology Education in Japan

The following are four major challenges facing technology education in Japan. How well Japan is able to meet these challenges will determine the nature and effectiveness of technology education in the future.

5.1 Entrance Examination Pressure

Highly competitive entrance examinations are an important aspect of education in Japan. Especially important are the university entrance examinations which determine which students will be accepted at prestigious Japanese universities. Since admission to prestigious universities will result in various lifelong advantages, parents encourage their children to begin preparing for entrance examinations at an early age. The national university examinations cover five major areas: mathematics, Japanese, English, natural science, and the humanities. The entrance examination does not include content from technology education, home economics, fine arts, or health education. As a result, Japanese parents tend to regard these subjects as subordinate to subjects that are included in the entrance examinations.

5.2 Difficulty of Curriculum Change

The intervals between major curriculum change are too long to reflect changes in technology and in the workplace. This is an especially important challenge for technology education, since the content of technology education is closely related to the world of technology and the world of work.

5.3 Technology Education and Equal Opportunity in Education

Japan is beginning to experiment with a shorter work week and shorter school week. During the 1992-93 school year, many Japanese schools will not have classes on Saturdays. As a result there will be less time available for instruction. This poses an especially important challenge for technology education and home economics education. To provide equal access to boys and girls, the Ministry of Education decreased the time allocated to technology education and home economics by 50%.

5.4 Lack of Resources for Technology Education

Technology education in Japan faces a lack of resources, both financial and human. Technology education requires continuing financial investment in facilities, equipment, and materials. More importantly, it is becoming increasingly difficult to recruit good technology education teachers. Many engineering and technology graduates are recruited by companies, leaving relatively few available to work as technology education teachers.

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Interdisciplinary Technology Programs in the Republic of Peru

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International Technological Literacy Symposium

Interdisciplinary Technology Programs in the Republic of Peru

Presented

by

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INTERDISCIPLINARY TECHNOLOGY PROGRAMS IN THE REPUBLIC OF PERU

INTRODUCTION

In an increasingly global competitive marketplace, the Third World nations are striving to keep up with the fast pace of ever-changing technological development and advancement. They are facing, among others, three major obstacles: technical problems, economic factors, and institutional constraints (Christiansen, 1980). All of these obstacles are pressing the technological change. To confront the obstacles and to meet the challenge, a concerted effort from the government, academia, and industry is essential.

Over the past thirty years, the Peruvian government has undertaken major reforms in education to strength the roles of the people in the restructuring of society and the increase of national self-sufficiency. The vocational and technology education in Peru have provided mostly the necessary trainings for its workforce.

EDUCATIONAL SYSTEM

In the Republic of Peru, education is free and compulsory for all children between six and 15. After completing six years of mandatory education, a student has the option of entering a five-year public high school or a two-year vocational high school. See Figure 1. No entrance examination is required for a student to enroll in a high school. In southern hemisphere, summer and winter seasons are opposite to that of northern hemisphere. In Peru, the fall semester starts in April. In 1990, according to Ministry of Education (1990), nationally there were over 800,000 students trying to enter 46 universities and technological institutes. However, only about the top 10% of these students were able to enroll in the universities. Of a total of 46 universities, more than 20 universities and technological institutes are located in the capital city of Lima. All universities are five-year institutions. Each university holds its own entrance examination which requires the students to take a test in five subject areas: Spanish, Mathematics, Physics, Chemistry, and Social Sciences.

National University Mayor of San Marcos is in Peru as Harvard University is in the United States. Although San Marcos is a national university. National

University of Education, on the other hand, is the national teacher university which provides the teacher training nationally for technological institutes and high schools.

As illustrated in Figure 1, there were two options for a high school graduate to pursue a higher academic degree: (1) entering a five-year university to receive a baccalaureate degree, or (2) entering a three-year technological institute to receive a diploma. There were a total of 10 technological institutes located in Lima which offered technology programs.

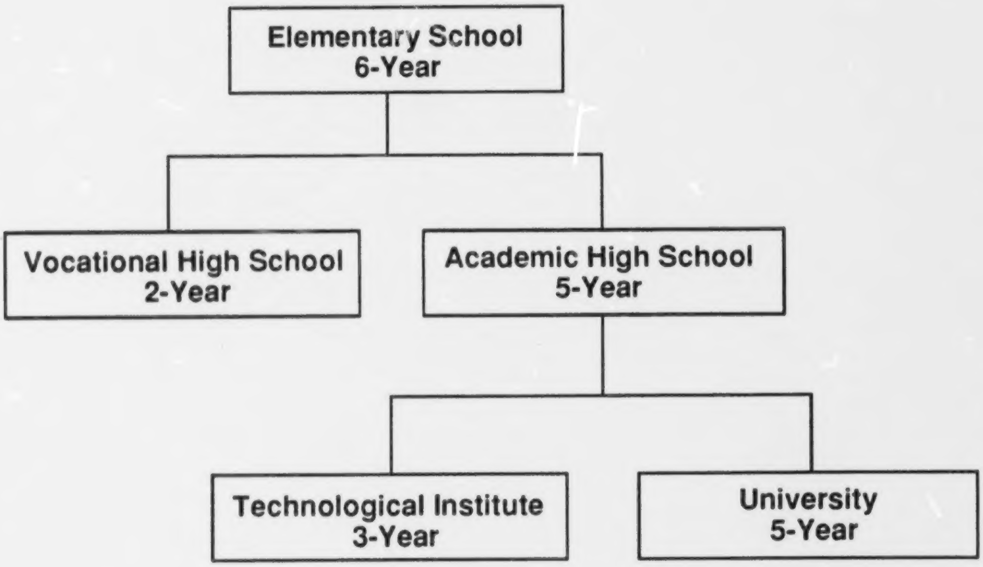
Elementary School 6-Year
Vocational High School 2-Year
Academic High School 5-Year
Technological Institute 3-Year
University 5-Year

Figure 1. The educational System in the Republic of Peru

TECHNOLOGY EDUCATION IN PERU

In the Republic of Peru, the major universities and technological institutes, and nearly 80% of the nation's industries are located in the capital city of Lima which has a population of six and a half million people (Britannica World Data, 1990, p.694).

The Ministry of Education has set a guideline for technology, vocational and technical education. Instructional programs at the universities and technological institutes vary in content and methodology from one institution to another.

Most technology programs in these institutes are single-disciplinary: electrical technology, electronics technology, or mechanical technology. Most of the institutes offered one or two of these programs. At National University of Education, all three programs are offered in the Division of Electromechanical Technology. A student is enrolled in one of these three programs based on his/her entrance examination score and according to his/her preference. Electronics, Mechanical, and Electrical Technology in this order are typically preferred by most of the students entering the Division of Electromechanical Technology.

Table 1 lists a five-year Electronics Technology program in the Division of Electromechanical Technology at National University of Education. The students are required to complete at least 201 semester hours for graduation. The program consists of 52% (105 hours) of humanities and social sciences, 10% (20 hours) of basic mathematics and sciences, and 38% (76 hours) of technological courses and technical electives (National University of Education, 1990).

Table 1
Curriculum for Five-Year
Electronics Technology Program

First Year	Ist Semester	2nd Semester
Spanish I & II	3	3
English I & II	2	2
Mathematics I & II	3	3
Religious Studies I & II	4	4
Physical Education I & II	1	1
Music Appreciation I & II	1	1
General Pedagogy	2	0
General Psychology	0	4
Electricity	4	0
Electronics I	0	4
TOTAL	22	22

Table 1 (continued)

Second Year	Ist Semester	2nd Semester
Spanish III & IV	3	3
English III & IV	2	2
Physical Education III & IV	1	1
Music Appreciation III & IV	1	1
Electronics II & III	4	4
Psychology of Children & Teenagers	3	0
Sanitary Education	1	0
Calculus	3	0
Technical Drawing	1	0
Organization of Electronics Field	2	0
General Science	0	3
Learning Techniques	0	3
Educational Psychology	0	3
TOTAL	21	20

Third Year	Ist Semester	2nd Semester
Spanish V & VI	2	2
Teaching Techniques I & II	3	2
Applied Physic I & II	4	4
Physical Education V & VI	1	1
Chorus I & II	2	2
Electronics IV & V	4	4
Educational Sociology	2	0
Schematics Drawing	1	0
Industrial Safety	2	0
Academic Organization & Administration	0	4
Industrial Probability Seminar	0	2
TOTAL	21	21

Table 1 (continued)

Fourth Year	Ist Semester	2nd Semester
Teaching Techniques III	1	0
Chorus III & IV	2	2
Electronics VI & VII	4	4
Physical Education VII & VIII	1	1
Teaching Intensive Practice I	2	0
Teaching Planning & Observation	1	0
Philosophy of Education	3	0
Peru and Historical Forms	3	0
Organization of Technical Shops	2	0
Tasks of Peruvian History	0	3
Geography	0	2
Peruvian Educational Problems	0	2
Great Educators	0	3
Administrative Pratice I	0	2
TOTAL	19	19

Fifth Year	Ist Semester	2nd Semester
Physical Education IX & X	1	1
Teaching Intensive Practice II & III	3	6
Electronics VIII & IX	4	4
Academic Evaluation	4	0
Industrial Electronics	4	0
Administrative Practice II & III	2	3
Electronics Seminar	0	2
Development of Electronics Teaching Materials	0	2
TOTAL	18	18

A survey was conducted by Yu and Garcia (1990) on the status and extent of Electromechanical Technology programs from 42 Peruvian educators at 15 higher education institutes (five universities and 10 technological institutes in Lima, Peru) working in the areas of electricity, electronics, mechanisms, fluids, microprocessor, and fiber optics.

PROFILE OF THE INSTITUTIONS

Size of Institutions: The number of full-time students in the institutions is shown in Table 2. An overwhelming majority (95%) of the Peruvian educational institutions indicated that their institutions had an enrollment of less than 4,000 full-time students, whereas only five percent represented institutions with an enrollment of 6,001 to 8,000 students.

Table 2

Percentage of Number of Student Enrollments

Student Enrollments	Number of Institutions	Percentage
Less Than 4,000	40	95.2
4,000 to 6,000	00	0.0
6,001 to 8,000	02	4.8
8,001 to 10,000	00	0.0
10,000 or More	00	0.0
TOTAL	42	100.0

Institution Operation: The data presented in Table 3 indicated the institution's operation. All but two institutions (95%) were in a semester system, while those two institutions operated in a bimonthly system.

Table 3
Percentages of Institution Operation

Institution Operation	Number of Institutions	Percentage
Quarter	00	0.0
Semester	38	95.0
Open Entry/Open Exit	00	0.0
Other	02	5.0
TOTAL	40	100.0

Program Students: The number of full-time students enrolled in electromechanical related areas is shown in Table 4. Eighty percent of the educational programs had more than 200 full-time students, 7.5 percent had 151 to 200 students, and 12.5 percent had 51 to 100 students in the program.

Table 4
Percentages of Number of Program Students

Program Student Enrollment	Number of Institutions	Percentage
Less Than 50	00	0.0
51 to 100	05	12.5
101 to 150	00	0.0
151 to 200	03	7.5
201 or More	32	80.0
TOTAL	40	100.0

Years of Operation: The years that the Technology programs had been in operation are illustrated in Table 5. Of all the programs, 55 percent have been in operation for more than 16 years, 24 percent with 11 to 15 years, and 19 percent with 6 to 10 years in operation. Table 4 revealed that most programs (78%) have been in operations more than 10 years.

Table 5

Percentages of Years of Operation

Years of Operation	Number of Institutions	Percentage
1 to 5	01	2.4
6 to 10	08	19.0
11 to 15	10	23.8
16 or More	23	54.8
TOTAL	42	100.0

PROFILE OF THE TECHNOLOGY PROGRAM INSTRUCTORS

The program instructors usually have a choice of teaching a combination of two out of three semesters/sessions: Fall semester, Spring semester, or Summer session.

Teaching Load: The teaching load of program instructors is illustrated in Table 6. Over 75 percent of the instructors indicated that they had 16 or more student contact hours per week, with 43 percent had a teaching load of 16 to 20 hours, 31 percent had 21 to 25 hours per week. This is largely due to laboratory assignment which requires more laboratory clock hours to be equivalent to the same number of credit hours of lecture.

Table 6

Teaching Load of Program Instructors

Number of Student Contact Hours	Number of Instructors	Percentage
Less than 10	03	7.1
10 to 15	06	14.2
16 to 20	18	42.9
21 to 25	13	31.0
26 or More	02	4.8
TOTAL	42	100.0

Number of Courses Taught: The number of courses taught by program instructors is shown in Table 7. Ninety-one percent of the instructors taught two to four subjects per semester, with 24 percent teaching two subjects, 43 percent teaching three subjects, and 24 percent teaching four subjects.

Table 7

Number of Courses Taught by Program Instructors

Number of Courses	Number of Instructors	Percentage
1	01	2.4
2	10	23.8
3	18	42.9
4	10	23.8
5 or More	03	7.1
TOTAL	42	100.0

Professional Growth: Over 70 percent of the program instructors indicated that they attended at least one workshop or training school each year. See Table 8. These workshops or training schools identified by the program instructors predominantly were sponsored by universities. Twenty-eight percent of program instructors did not attend any workshop or training school as shown in Table 8. This is an alarming signal that higher education technology educators were not keeping pace with the development and advancement of changing technology.

Table 8

Numbers of Workshops or Training Schools Attended

No. of Workshops Attended	Number of Instructors	Percentage
0	12	28.6
1	11	26.2
2	12	28.6
3	02	4.8
Other	05	11.0
TOTAL	42	100.0

Educational Level: The data presented in Table 9 show the program instructors' educational attainment levels. The table indicated that 68 percent of the instructors had attained the bachelor's degree, and 28 percent had associate degrees. There were two instructors who had a master degree.

Table 9

Percentages of Highest Education Attainment

Educational Level	Number of Instructors	Percentage
Associate Degree	11	27.5
Bachelor's Degree	27	67.5
Master's Degree	02	5.0
Doctorate	00	0.0
Other	00	0.0
TOTAL	40	100.0

CONCLUSIONS/SUMMARY

The technology program must be revised, changed, and updated continuously. Sharply focused programs run the risk of rapid obsolescence for both graduates and program itself (Yu, 1987, p. 7). Single-disciplinary technology program such as electrical technology, mechanical technology, and electronics technology at the Peruvian higher education institutes have been in place and remain unchanged for many years. As Smith (1984, p.7) pointed out that graduates with interdisciplinary skills and knowledge do not just emerge. They must be prepared through well designed programs that include a broad knowledge based, system oriented approach required to apply the needed interdisciplinary skills.

One of the major problems confronting current leaders in technology education is to remain in the forefront of technological development. Peruvian higher education technology educators are not abreast of ever-changing technological development and advancement, and the deficiency and lack of state-of-the-art equipment make their graduates ill-prepared, non-responsive, and adaptive to any new or specialized application areas or technology. This has been acutely true in many developing nations.

The policy on technology education in the Republic of Peru must be refocused and readdressed in areas such as financial support by the government, quality of higher education technology program curricula and training facilities, higher education faculty development programs, the system of evaluating the effectiveness of technology education, and the technology education delivering system.

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Business Education Partnerships, A Role in Enhancing Technological Literacy

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Business Education Partnerships - A Role in Enhancing Technological Literacy

INTRODUCTION

Technology is not something which is confined to specialist functions such as engineering, electronics or physics. It is something which affects all of us in our everyday lives - at our places of work, in our homes and in our communities. Young people today are being brought up in an increasingly sophisticated and technological world and it is our responsibility to provide them with the skills and abilities which will be required in tomorrow's environment. We **all** have a role to play in our societies, economies and communities - as individuals, as business-people and as educators.

In today's rapidly changing world, we can no longer expect to do the same job for our entire working lives. We must be flexible, adaptable and willing to learn. We must learn to proactively and positively manage change rather than reactively and negatively be affected by change.

I do not come to you today with all the solutions to how we build and enhance technological literacy, but I hope that I come with some ideas for the way ahead. Not just ideas on **what** could be done, but also some suggestions on **how**. For too long, in both the public and private sectors, problems have been ignored or money has been thrown at perceived problems that are not fully understood. If we, as business and education, work in partnership to define the needs, identify solutions and deliver programmes, we will be more cost-effective and will maximise the benefits.

EDUCATION BUSINESS PARTNERSHIPS

Before talking about specific ways in which business can help enhance technological literacy, I would like to set the scene by exploring ways in which business and education can work together.

Partnership is not a one-way process, where education is simply providing industry with school-leavers, or business is simply donating money to worthy educational causes, it is a **working relationship based on interdependence and mutual benefit**. Both sides have much to offer each other if only they take the time to talk, discuss and share.

It needs **mutual understanding and influence** where both education and industry help each other to their mutual benefit and to the benefit of society and the economy.

Why should industry get involved?

Firstly, because it is in our own **long-term interest**.

As business, we will not be able to operate effectively, efficiently or profitably unless we are operating in a healthy and **thriving economy**.

There is a need for better **informed citizens**. If our operations and activities are understood by the communities in which we work (and we as a company may need to be more open in the ways we communicate), then it is much more likely that our "**licence to operate**" will be granted and maintained by these communities. A "licence to operate" is not a piece of paper - it is acceptance of our business; local communities want us to be there.

There is also a need for **young people to be better prepared** for the adult world. Students should have an understanding and appreciation of the role of business and industry, and they should aquire the capabilities and skills to survive in, and contribute to, society and the world of work.

But these are all long-term reasons, with benefits that are undoubtedly there but are very difficult to measure. Business should also work with education for shorter-term reasons.

Our **local reputation** is critically dependant on the role we play in our local communities. If we get this wrong, it can seriously affect our ability to do business. For example, we may not be able to expand our industrial plants or recruit local people.

Our own employees can gain tremendous benefits from their work with local communities, through learning new skills and being exposed to different environments. This sort of **staff development** is invariably of direct benefit to the company and can form part of a planned and measured process of appraisal and develoment.

A significant benefit comes from the **exchange of services**. As I said earlier, the partnership is a two-way process and both education and business benefit from exchanging people, information, expertise and facilities.

A central feature in all of this is the role of our individual employees. No amount of good words or senior management commitment will achieve anything without the practical contributions made by our people. As a company we need to acknowledge these **personal motivations** and capitalise on them by providing encouragement and support to our employees.

Barriers

This may all sound quite straightforward, but the cultures of education and business have not always had a history of working together. We need to understand and appreciate each other's environments, and also appreciate that the time and effort we spend is not a cost but an **investment**. We also need to be aware of what some of the barriers to partnership are, not because they are insurmountable, but so that we can challenge and overcome them if they arise. These barriers may include areas as diverse as industrialists having a fear of schools because they are unused to going into them, difficulty finding or justifying the time involved, or too much focus on short-term business or educational priorities.

BUSINESS POLICY - BP'S EXPERIENCE

If a company is going to take working with education seriously, there needs to be a policy and strategy outlining how and why the company wants to get involved. This is not to define the specific activities which individual employees and local educational institutions can undertake, but to provide senior management support, encourage employee involvement and legitimise the activity.

I can offer you the example of BP in this area. Not because we have got all our relationships with the community and education right, but because I believe we have got some of our thinking straight and are moving in the right direction.

Mission and Objectives

BP has a clear mission statement for working with education which is derived from the vision and values statement for BP as a whole, and which states that "we expect to involve ourselves in and contribute to local communities and education". But what does this commitment mean in practice. We determined that our **mission** is:-

"To apply BP's Vision and Values by working with and supporting education, to the mutual benefit of the company and the many communities to which BP belongs"

We also identified four **objectives**:-

Firstly - "to contribute to a **healthy, sustainable economic and social climate** in which the company can operate profitably"

Secondly - "to help maintain a **licence to operate by developing a sound and positive reputation** for constructive liaison with education, both at the local community level and in our wider spheres of influence"

Both these objectives recognise the need for us to get the balance right between short-term profitability and long-term sustainability. We need to invest time and money in education, as a vital part of the community in which we operate, in order to achieve the necessary infrastructure and positive support from it that we need.

Thirdly - "to help secure **short and long term human resource needs** on behalf of our company and our industry, including our contractors and suppliers". In addition to the obvious stake we have in this area, this objective also gets us involved in the more general issues around learning for work and learning for life.

The fourth and most ambitious is "to maximise the **mutual benefits** to be obtained from collaboration based on the specialist expertise and services which education and business offer each other". A key dimension of this, and one which is still a long way from being fully realised, is the development of the concept of "learning organisations". Learning organisations are those which do not operate in isolation within their environments, but which are prepared to listen, learn and change to suit their environments. They "learn", from dealing with and working with others, how to benefit from and manage change rather than have change imposed on them. This is an area where both education and business need help, yet one where we will be inefficient if we try to resolve the problem alone. This is clearly an area where we can help each other, to our mutual benefit.

Strategy

Although BP is involved in working with education in over 40 different countries, we still have a lot to learn and a lot to do. This will require a deliberate strategy applied patiently and flexibly over several years. This strategy has four main features:-

- a **balance** between investing money, investing time and communicating effectively
- a "**partnership not sponsorship**" approach
- the encouragement of **employee involvement**
- working with education as a **normal part of doing business**.

Balance

We are failing to maximise our investment unless we have a balanced approach to our work with education. It is not enough to simply fund a worthwhile project and feel that we have done our bit. How much better if we can also contribute to the thinking, planning and realisation of that project if we also invest our time and our expertise. It is also not constructive for a company to complain or insist that education is not delivering what it needs unless that company is prepared to commit its resources to do something about the situation. We should be involved in a balanced mixture of resource provision, expertise provision and communication and influence.

Partnership not Sponsorship

This concept further develops the need for a balanced approach. Company support for education often begins as sponsorship, but can develop into partnership. To give an example of this:- BP recently agreed to support an environmental education programme in Scotland. The local public affairs officer got involved in the planning and a senior manager was brought in to give the launch speech. It was a good project, and that could have been no more than a satisfactory end to the story of a good piece of sponsorship.

But partnership only began when BP staff involved as link officers with local schools started to work with teachers and students on aspects of environmental education of mutual interest. This created insights into different perspectives and generated a two way influence. It also started to create ideas for new projects, with both partners becoming committed to work together on further project development.

The key features of sponsorship and partnership are summarised below:-

Sponsorship	• **Partnership**
Highly dependent on $$$ for impact	• $$$ of less importance
Reactive	• Proactive
Tidy, containable, minimal staffing requirement	• Diffuse, open-ended, based on staff involvement and empowerment
Business pays for what education wants	• We learn and find solutions together
Arms length - two cultures touch without changing	• Ideas exchanged; understanding and mutual respect developed

Employee Involvement

Many BP employees are already directly involved in working with education, while many others only need a little encouragement or help. Natural motivation comes from parental, local community and academic subject or vocational skill interests. The activities involved also enrich jobs and provide personal development, while it does a great deal for the morale of employees to be used and trusted as ambassadors for the company.

But all this needs to be legitimised, encouraged and recognised. The trick for a company is to do more than merely permit these activities. We need to capitalise on the motivations and natural enthusiasm of our people by giving them support and encouragement and by recognising and valuing the work they do.

Part of doing business

If relationships with the community and education are to be sustained they must become a normal part of doing business, not an add-on which is nice to have but which can be cut during hard times. This work has to be recognised as a critical investment in the future, and not an unnecessary cost.

An example of one area where BP has achieved this objective, is in our school links scheme in the UK. BP has been involved in links between its sites and their local schools for almost 25 years. For each school, at least one "link teacher" provides a point of contact and a channel for BP to work with the whole school. Similarly, at least one BP "link officer" provides a point of contact and a channel for the school to work with the BP site.

Over the years, the sorts of activity undertaken as part of the link scheme have become increasingly sophisticated, and the relationships which have built up between the schools and BP have become stronger. The number of people involved and committed to maintaining the links (over 300 BP link officers) and the level of activity has created an unstoppable momentum. The company continues to support the programme at all levels from local site managers allowing employees time "off-site" through to the head office providing a range of induction and training events, all of which helps ensure momentum and quality are maintained. Nevertheless, even without this support, the activity is now so firmly embedded, not just in the minds of a few managers, but in the lives of so many individual employees, that it would continue to happen at least in an ad hoc way - it has become a "part of doing business".

ENHANCING TECHNOLOGICAL LITERACY

I make no apologies for taking so long to get to this point! It is important that companies and schools do not simply rush into activity in an area of mutual concern or interest. If we do not first of all understand the basic principles of partnership, we may start with the wrong activity or, at best, do a good job but perhaps not the best or most cost-effective we could have done. Although the earlier part of my presentation has been on the general issues, the principles discussed are as applicable to technology education as to any other aspect of business education partnership activity.

The role of Business

Business clearly has a role to play in enhancing technological literacy. Although, as I said earlier, the whole of society is increasingly technological, a company such as BP has a particular interest in this area as our business is so directly involved with science and technology.

There are a number of ways in which business and education can work together to enhance technological capability.

- Working towards **developing the skills and capabilities** employees will require in the future:-

Foreseeing the future is never easy but, as I said earlier on, the one thing we can be sure of is change. This has significant implications for the ways in which our employees work today, and the expectations of modern business will certainly affect the future of our young people.

While academic knowledge and vocational skills will, of course, continue to be valued, transferable skills and the principles of lifelong learning are increasingly important. Companies are no longer interested purely in the brilliant academic who is an expert in one specialised area. Similarly, industry will only be interested in good craftspeople, technicians and assembly workers if they also have other skills and are willing and able to adapt to changing work methods, needs and priorities.

This can be illustrated by the example of an assembly process in a BP plant. The employees used to have a fixed task to do and were not expected to get involved in other areas of the total process. If the machine they were working on broke down, they would stop work while the appropriate technician was called to put things right. Not any longer! Now, if a machine stops working, the operator is expected to consider why the breakdown has occurred and, if possible and practical, effect a repair. In this way, reduced downtime has improved productivity. Even when specialists are still required for repairs, they are assisted by a full briefing from the operator on the cause and location of the problem.

This example raises a vital issue. If we expect our employees to learn and demonstrate such skills, we must treat them as people and not as extensions of the machinery or plant they work on. We, as companies, still have a lot to learn about how to really value our human resources and how to view our employees as valuable assets rather than expensive overheads.

Our future employees will need to have a wide range of transferable skills, from familiarity with computer technology through communication skills such as literacy and numeracy to general problem solving abilities. Most critical of all will be the ability to adapt, to challenge conventional ways of doing things and to learn new skills and knowledge. The key to the future for today's students will be the ability to "learn how to learn".

- **Providing resources, materials and facilities**

By providing access to our sites and our people, we can make technology more interesting and exciting. We can provide "real" contexts and "real" problems which show students the relevance and value of technology.

In my experience, students need to understand the application of technology and appreciate its relevance to their own lives. If it is simply a subject with no context or perceived value, many potential technologists of the future will lose interest.

To give simple examples from our home environment, if our car will not start or a cupboard starts to fall off the wall, we are left with a choice - we either fix the problem ourselves or we call in an "expert" and pay the price. Technological capability in our home lives is frequently driven by financial constraints rather than enthusiasm for the activity!

If we can show our students why technology is important and how it will be of benefit to them, we will provide real motivation to learn.

- **Bringing new ideas, different perspectives and employees expertise**

As industrialists we are certainly not experts on how to educate our young people. We do, however bring different views and ideas. We may bring special knowledge or skills.

This is one area where partnership can be really beneficial. Having identified a particular need in education, the involvement of industrialists in resolving the problem can often be highly productive. They can make a valuable contribution in numerous ways ranging from specialist technical input to project management skills.

In the spirit of partnership rather than sponsorship, I do not believe it is efficient for industry merely to provide money. BP's work with education is focussed very much on areas where the company has knowledge and expertise, and can therefore make a valuable contribution through input from our employees. In this way, I believe we add significantly to the value of our work with education. We can bring our awareness of the modern business and industrial environment to provide contexts for learning and to help make education more relevant to today's working environment.

- **International dimensions and awareness**

The world we live in is becoming smaller as travel and communications constantly improve - themselves outcomes of technological advancement. BP can bring its perspective as an international company to the needs of technology education and the future. As we move towards a truly international society, the markets we all operate in also become international as well as local. We buy from, sell to, manufacture in and recruit from the whole world.

Where is education in this? Certainly some subjects, such as history or geography, will always have a strong local or national dimension. But the processes and outputs of education are likely to need to move towards a commonly agreed international framework, and technology education can lead the field in this. In addition to the transferability and relevance of technical knowledge across the world, many of the processes and skills involved in technology are also transferable.

We need to share experiences and learn from each other. We should not be too parochial and assume our systems are the best in the world. Neither should we discount our own ways of doing things and try solely to follow the perceived success of other areas. Everyone has something to contribute and we should consider good practice close to home before rushing to adopt the methods of others.

THE CASE FOR COMMON CURRICULA

This leads me to suggest that there is a need to develop common technology education curricula across the world. As our students increasingly view the world as a single market, their skills, knowledge and achievements need to be recognisable and acceptable to both employers and institutions of further education across the world. And I believe that this will apply, not only in areas of technical specialism such as applied engineering or technical research, but also in the application of all those technological skills we all need in the modern world.

I can assure you that I am not suggesting that all students across the world should study technology in exactly the same prescribed way. It would not be helpful if governments chose to legislate in order to achieve this objective. What I do suggest is the need to develop a common **framework**, involving the development of key skills (such as familiarity with different materials, appreciation of market needs and problem-solving and team-working abilities) and the transferability of standards.

This may sound ambitious, and you may consider this to be an impossible objective given the variety of cultures and economic conditions around the world. The international development of technology education is, indeed, a vision for the future and I offer no "quick-fix" solutions for achieving the vision. I can, however, offer two examples which may demonstrate that the principle can work.

Firstly, I would like to look at technology education in the UK. Scotland has a different curriculum from the rest of the UK but, although the details of the curriculum are different, there are the same core components. Delivery may vary and development of key skills may take place in a different way, at different ages or through different subjects, but the key issue is that students across the UK can all aquire a similar level of awareness and capability. The routes may be different but the objectives and outcomes are similar.

Secondly, I would like to return to my earlier discussion on BP's policy on working with education. This policy is international and has now stood the test of time by proving to be acceptable in all of the 70 countries in which BP operates. Despite huge cultural differences, the success of the policy lies in its flexibilty in local interpretation. It is not prescriptive, but provides a framework and a set of principles of good practice, while allowing local BP sites and their communities to define the specific activities which are best suited to their particular needs and environment.

The need is to have a common and agreed framework, while allowing flexibility to accomodate local interpretations and variations on key themes.

WHAT BP HAS CONTRIBUTED

But what, specifically, has BP done to contribute to enhancing technological literacy?

Materials to support the Curriculum

BP's Educational Service has been producing materials and resources to enhance technology education for many years. These are not intended as syllabus materials, nor do they replace conventional textbooks. What they do bring is industrial relevance, and are intended to stimulate and excite students by **enhancing** the curriculum. BP produces a wide variety of products ranging from simple wallcharts and leaflets to complex resource packs and computer simulations.

Why does BP produce resource material?

There are a number of reasons why we find it both appropriate and beneficial for BP to provide materials:-

- demand from teachers and students
- to give an industrial perspective
- to stimulate students' interest in technology
- to help BP employees build links with local schools and colleges

How does BP produce resource material?

Defining the needs of students and teachers, and deciding to produce materials, is not in itself enough. It is important to do things in the right way and to acknowledge and use the skills and expertise of our partners in both education and business. Resources are therefore produced:-

- to help build business education partnerships
- with the active involvement of teachers and other educators
- as outcomes from the experiences of teachers spending time in BP
- from ideas generated by BP employees and teachers working together
- following trialling in schools prior to publication

A display of some of the materials BP produces is available at this conference. If anyone would like further information, please contact myself or my colleagues in BP Exploration in Anchorage or BP America's head office in Cleveland.

Partnerships for Technology

When the new National Curriculum was introduced in England 2 years ago, the role of technology as a subject was greatly enhanced. Technology is delivered across the whole curriculum, is interlinked with other key educational themes such as economic understanding, and the role of business and industry is critical to the effective delivery of technology education.
There are 5 aspects which all students must study from the ages of 5 - 16:-

- Identifying needs and opportunities
- Generating a design
- Planning and making
- Evaluating
- Information technology

This is a radical new process, where technology is not merely regarded as a vocational subject in isolation, but contains both academic and vocational elements, and has a cross-curricular and business relevance. It has been difficult for "traditional" technology teachers to adapt to the needs of the new curriculum, with the result that a lot of support is required, both with new materials and in training provision.

Providing educational resource materials is one way in which a company can work with education. However, simply providing materials does not necessarily encourage business and education to work together, nor does the provision necessarily result in the effective use of the materials in the classroom. To effect real change, it is necessary to provide training as well as materials, and not only training for the teachers but also for their colleagues in industry who can add value to the use of the materials through enhancing delivery in the classroom.

When BP started to explore ways in which we could help deliver the new technology curriculum, it rapidly became apparent that many of our existing resources would be valuable. The real needs of teachers and schools would be training in how to use these effectively.

Thus, "Partnerships for Technology" was born. This has evolved into a comprehensive programme which builds on the strength of selected materials produced by BP. Training is delivered by a team of "BP Fellows", supported by a "Technology Bus". Most importantly, a critical dimension of the programme is the active involvement of industrialists. Training is not delivered as a fixed package - the needs of local schools are negotiated by the schools themselves, the local education authorities, BP sites and, where appropriate, other companies. The project thus builds from the activities of existing local partnerships between business and education and, indeed, frequently helps to set up or strengthen such partnerships.

Following a recent month-long experiment, working with schools and BP sites across mainland Europe, we have shown that, although the project was conceived from the needs of the UK curriculum, its flexibility in methods of delivery make the model transferable to other countries, cultures and educational systems.

Design and Technology in Scotland

BP has been working in partnership with educators in Scotland for many years. Having made a significant contribution to technology education for 12 - 18 year olds through the production of our "Craft and Design" packs, we recently started to consider what BP could and should be doing for younger students. As in England and Wales, the development of the Scottish curriculum has resulted in all 5 - 12 year old students being required to study technology. Again, technology is not taught as a discrete subject, but is delivered across the curriculum with links to other subjects and the world of work.

In this case, the problem was not to retrain traditional technology teachers to adapt to a new curriculum. The problem was to make technology understandable and non-threatening to a group of teachers, most of whom had no real knowledge, understanding or education in the subject. Furthermore, the concept of primary or elementary schools having links with business, or using industry as a context for learning, was also not well established.

A group of BP employees got together with some primary school teachers and the Scottish Curriculum Council to identify the needs of both industry and education. The resulting project, "Science Design Technology and Industry", aims to build from the success of the earlier "Craft and Design" materials. Currently, a number of units are being produced by writing teams which include industrialists as well as teachers. These are theme based, use business contexts and aim to incorporate key learning experiences in technology, science and economic and industrial awareness.

CONCLUSION

I hope that I have been able to give you a flavour of how business and education can work together to their mutual benefit and, in particular, give some pointers as to ways in which companies can get involved in enhancing technological literacy.

I would like to conclude with some thoughts on the similarities between education and industry for, once the similarities are appreciated, it opens the door for the two sides to work together more effectively.

In considering the "outputs" of a company, the need for all the component parts of that company to produce profits and a healthy bottom line is a critical driving force. However, equal importance needs to be given to the good performance of the company in longer term cross-business issues such as environmental performance, equal opportunities and national and local community involvement. The total output or performance of a company is the combination of these two dimensions.

The outputs of education can be considered in a similar way. Whereas companies are composed of business units driven by bottom line needs, education is commonly composed of subjects or academic disciplines driven by examination result needs. However, education also needs to pay attention to the longer term cross-curricular issues such as economic understanding, technological capability and work-related skills and attitudes. The total output of a school or college is a combination of both dimensions.

In education business activities, we may be able to contribute in a small way to each others bottom line activities. However, once a partnership develops, with the emphasis on mutual benefits, mutual influence develops in the cross-business and cross-curricular areas.

Teachers and students can make an enormous contribution to the way industry operates through, for example, challenging our environmental performance, contributing to our employee training programmes and helping us to understand the needs of our local communities. Equally, business can bring its different perspectives to challenge academic boundaries, enhance economic understanding, make modern technology available and provide information on working environments and practices.

But partnership and mutual influence can involve even more than this, and can be more than simply contributing to each others needs. If business and education get together to identify mutual problems and issues, and work together to achieve change, the benefits to both partners will be even greater.

We need to stop thinking solely of our own agendas. Working together on our mutual agendas will lead to a real partnership for change.

Finally - what is the **vision** for the future?

I hope that business and education will cease to regard themselves as two separate cultures, and that working together will become a natural activity and a normal part of doing business. If the wealth creating sector can work together in partnership with the human talent developing sector, we will jointly contribute to enhancing the quality of life for us all.

Brian Swanson
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-Why Business should work with Education (BP Educational Service, 1988)
-Education and Business - A Vision for the Partnership (BP Educational Service, 1991)
-Partnership - a normal part of doing Business (due for publication, June 1992)

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